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Exploring Healthcare Chatbot Information Presentation: Applying Hierarchical Bayesian Regression and Inductive Thematic Analysis in a Mixed Methods Study

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EXPLORING HEALTHCARE CHATBOT INFORMATION PRESENTATION: APPLYING HIERARCHICAL BAYESIAN REGRESSION AND INDUCTIVE THEMATIC ANALYSIS IN A MIXED METHODS STUDY

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ABSTRACT

High blood pressure, also known as hypertension, significantly increases the risk of heart disease and stroke, which are leading causes of death in the United States. While contributing to over 691,000 deaths in 2021 alone in the United States (U.S.), it also imposes immense economic burden on the healthcare system, costing approximately $131 billion annually. One way to address this issue is for increased self-care behaviors and medication adherence, both of which require sufficient health literacy. Despite the importance of health literacy, 90% of U.S. adults struggle with health-related subjects. Overcoming the issues associated with health literacy requires addressing the inherent challenges of presenting health information as it is often unfamiliar, complicated, and exceptionally technical. However, with the advent of large language models (LLMs) such as ChatGPT, there are new opportunities to deliver health information more effectively and accessibly in the form of chatbots and conversational agents (CAs).

This thesis takes a mixed-methods approach to investigate the effects of varying information presentation styles on a healthcare chatbot's effectiveness, trust, and usability to assist users in a health-related information seeking task. Controlling for the communication style (conversational or informative) and language style (technical or non-technical), participants engaged with a healthcare chatbot to learn about blood pressure and hypertension. They then engaged in a semi-structured interview detailing their experience and ideating on future health information presentation designs for chatbots and CAs. Hierarchical Bayesian regression models were created to provide inference for how varying information presentations affected the chatbot's effectiveness, trust, and usability.

Moreover, inductive thematic analysis was conducted to analyze the qualitative interviews. The findings revealed dynamic interactions between the various information presentation styles and the outcome measures. Moreover, the qualitative interviews provide evidence for diverse information presentations styles to enhance usability and ease cognitive load for health-related information. These results suggest the importance of tailoring health information presentation to users' cognitive abilities and preferences to enhance learning of health-related information. As chatbots and other CAs become increasingly used to disseminate health-related subjects, ensuring effective communication and usability will become increasingly more prevalent.

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE:
INTRODUCTION

High blood pressure, otherwise known as hypertension, poses a significant health risk, as it increases the likelihood of heart disease and stroke – which are leading causes of death in the United States (National Center for Health Statistics, 2024). Hypertension was a primary or contributing factor in over 691,000 deaths in the country in 2021 alone (National Center for Health Statistics, 2024), and nearly half of adults in the United States (48.1%, 119.9 million) suffer from hypertension or are taking medication for this condition (Million Hearts, 2023). Despite its prevalence, nearly 1 in 4 adults (22.5%, 27.0 million) with hypertension have their hypertension under control and close to half have uncontrolled hypertension (45%, 37 million) (Million Hearts, 2023). The effects of high blood pressure in the United States impose significant costs on the healthcare system, incurring approximately $131 billion per year, averaged over the period from 2003 to 2014 (Kirkland et al., 2018). These statistics underscore the critical need for effective hypertension management and education initiatives for public health and associated healthcare costs.

Prevention of High Blood Pressure

Blood pressure is an integral component of the circulatory system and indicates the pressure exerted on blood as it travels throughout the body's arteries (Galton, 1973; N. M. Kaplan & Lieberman, 1979; Wade, 1975). It is comprised of the systolic pressure and diastolic pressure (Wilson & Childre, 2007). The systolic pressure, or the top number of a blood pressure reading, reflects the maximum pressure in the arteries as the heart contracts to distribute blood in the body, while the diastolic pressure measures the minimum pressure

in the arteries when the heart is relaxing in-between contractions (Wilson & Childre, 2007). Normal blood pressure is defined as a blood pressure at or below 120/80 mmHg, but an individual with hypertension, the systolic and diastolic blood pressure is at or greater than 130 mmHg and 80 mmHg, respectively (Whelton et al., 2018). When blood pressure is too high, it damages the walls of the arteries, accelerating the ailment of atherosclerosis, which causes the arteries to harden and reduces the arteries' elasticity. This can have dangerous effects, as the hardening of the arteries over time increases the risk of brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure (Galton, 1973; N. M. Kaplan & Lieberman, 1979; Wade, 1975). While there is no cure for hypertension, the use of prescribed medication and implementing healthy lifestyle changes can reduce an individual's blood pressure levels and enhance their quality of life (Kimani et al., 2019; Ojangba et al., 2023). Increasing physical activity may lower blood pressure, with recurrent and relatively brief periods of low-intensity physical activity can significantly improve an individual's health and blood pressure levels (Ojangba et al., 2023). Such activities could include walking, bicycling, and swimming, which improve blood flow and are particularly beneficial for individuals with hypertension (Wilson & Childre, 2007). Conversely, isometric exercises such as heavy weightlifting are generally not recommended (Wilson & Childre, 2007). As the lifetime risk of developing hypertension is approximately 90% (Vasan et al., 2002), it is crucial for the general population to engage in informed-decision making for the effective self-management of this widespread disease (Lou et al., 2023).

Importance of Health Literacy

One way to address this issue is for increased self-care behaviors and medication adherence (Motlagh et al., 2016), which are associated with health literacy (Miller, 2016; RobatSarpooshi et al., 2020). Health literacy in the United States has been identified as a crucial factor influencing health disparities and health outcomes (Yee et al., 2016), as nearly 90% of adults struggle with health-related subjects (NNLM, 2023). Defined by the CDC as the ability to access, understand, and utilize information and services for health-related decisions (CDC, 2023), the U.S. government's Healthy People 2030 initiative highlights the enhancement of personal health literacy as a paramount goal for the betterment of overall health and well-being for all people ("Healthy People 2030 Framework," 2020). There exists disparities in health education among different populations, with limited health literacy being pronounced among racial and ethnic minorities, rural inhabitants, and those with less education and literacy skills (Kutner et al., 2003; NPR et al., 2018), which imposes challenges to effectively communicate health-related subjects to the general population. Nonetheless, studies have shown levels of low health literacy to be associated with decreased adherence to self-care tasks (e.g., maintaining a healthy diet, weight, management, and physical activity) (Larki et al., 2018). They have also provided evidence that health literacy is directly linked to hypertension knowledge, which is recognized as an independent predictor of hypertension control self-efficacy (Nam & Yoon, 2021). Among hypertensive patients, health literacy is associated with improved quality of life, highlighting its impact beyond clinical outcomes (C. Wang et al., 2017). With the growing access to internet across broader populations, technologies

such as mobile health apps, telemedicine, digital communication tools, and online health information resources, have grown to be powerful platforms for the promotion and improvement of health literacy (P. J. Fitzpatrick, 2023). Recently, an increasingly popular method to deliver health information is through healthcare-based conversational agents (CAs) and chatbots.

Emergence of Healthcare Chatbots and Conversational Agents

The advent of large language models (LLMs) such as OpenAI's ChatGPT and Google's Bard have resulted in new opportunities to deliver more effective and equitable healthcare information through web-based CAs and chatbots (Karabacak & Margetis, 2023). Previous research has demonstrated the efficacy of chatbots to effectively disseminate health information. Notably, past healthcare chatbots have been used to disseminate virus and vaccine education during the COVID-19 pandemic (Amiri & Karahanna, 2022). CAs have also effectively assisted individuals with diet recommendations, smoking cessation, and cognitive behavioral therapy (Fadhil, 2018; K. K. Fitzpatrick et al., 2017; H. Wang et al., 2018). Considering these applications, it is important to acknowledge that healthcare related information is often unfamiliar, complicated, and exceptionally technical ("Understanding Health Literacy," 2023). There may be socioeconomical factors that are associated with lower levels of health literacy and access to consumable health information (Kutner et al., 2003; NPR et al., 2018). As such, the application of this technology for healthcare-related contexts necessitates designing the human-AI interaction to meet the needs of its users. Considering the varying requirements and needs of users with healthcare-based technology is crucial to prevent intervention-

generated inequities in healthcare technology (Benda et al., 2020). Neglecting inclusivity in healthcare design can lead to dangerous outcomes (Benda et al., 2020), as demonstrated by research indicating parents with lower health literacy exhibit a significantly higher likelihood of making dosing errors when administering liquid medication to their children (H. S. Yin et al., 2010). As healthcare chatbots and CAs increasingly handle tasks such as medication reminders and dosage information (Altamimi et al., 2023; Maia et al., 2023) and other aspects related to the dissemination of health information, it becomes crucial to ensure the interaction humans have with AI meets users' individual needs. Given this, to fully harness the capabilities of CAs, further research is needed to understand optimal design strategies for their effectiveness, especially when addressing complex communication contexts such as health information.

Previous Research in Healthcare Chatbots

Most prior studies have investigated users' perceptions and intentions to use chatbots in a general context, examining positive and negative characteristics which lead to different outcome measures such as acceptability and trust. For example, previous research has noted the influence of anthropomorphic design cues and communicative agency framing, emphasizing the significance of human-like cues (Araujo, 2018). Nicol et al. (2022) demonstrated the acceptability of chatbot-delivered cognitive-behavioral therapy for adolescents with depression and anxiety. Another study examined the effect of a motivational chatbot compared to a neutral chatbot on promoting smoking cessation and found no significant difference in engagement or perceived empathy between the two chatbots, but both chatbots were found to be effective in motivating smoking cessation (He

et al., 2022). Nadarzynski et al. (2019) showed that while most internet users would be receptive to using healthcare chatbots, concerns about the quality and accuracy of the information provided may hinder engagement, emphasizing the need for user-centered and theory-based approaches to design effective AI chatbots. Despite these efforts, the field of human-AI interaction still lacks unified models to explain the fundamental aspects of the interaction experience with conversational AI (Rapp et al., 2021).

AI Information Presentation Design Strategies

Given the proliferation and the increasing capability to implement this technology in a variety of contexts, the models supporting these designs will grow in importance. A key characteristic of this, is the context of the interaction experience in various presentation modalities employed by chatbots (i.e., text, verbal, visual) and how this influences user preference (Vaidyam et al., 2019). When designing chatbots for health education, minimizing the cognitive load of the user is an important aspect to consider, as this can lead to users being more likely to adopt it (Al-Maskari & Sanderson, 2011). Cognitive load encompasses the effort to process and memorize new information for decision-making and is categorized into two types: intrinsic and extraneous. Intrinsic cognitive load is determined by the inherent complexity of the information, while extraneous cognitive load pertains to how information is presented (Sweller, 2010). Past research has examined extraneous cognitive load in the context of healthcare chatbots as Biro et al. (2023) found that the usability of the chatbot was greatly influenced by the chatbot persona and the chatbot's effectiveness was significantly impacted by the use of technical language. Within healthcare patient portals, Yin & Neyens (2024) showed videos are more effective at

conveying health information, while text-based methods to convey health information is more efficient for users. While this study did not specifically utilize chatbots to convey health information, it highlights the potential to integrate healthcare patient portals with multimodal chatbot interactions. Given this, there is a need to better understand how specific contexts influence the communication of information by healthcare chatbots.

Bayesian Framework

Various statistical techniques could be applicable for assessing the interaction between humans and AI. Among these, Bayesian statistical methods might be most suitable for comprehending user interaction experiences with conversational AI. The variability in human interaction experiences with technology poses a challenge to statistical modeling. Additionally, considering the diverse levels of health knowledge and reading literacy in the general population, there may be significant variability in interaction experiences. Due to the inherent uncertainty in human-AI interaction, a Bayesian approach may be useful due its provision of a quantitative framework for modeling uncertainty. The major benefits of a Bayesian approach are for the incorporation of additional knowledge, facilitating statistical analysis with limited data and smaller effect sizes (Neyens et al., 2015). For this, Bayesian analysis effectively aligns with the culture and incentives of human-computer interaction (HCI) research as it allows for rapid learning and the application of existing knowledge to address new questions (Kay et al., 2016). By capturing the variability through the modeling of uncertain and random parameters with distributions reflecting population uncertainty, this methodology may be more advantageous than traditional frequentist

approaches that result in regressing to the mean and thus discount underrepresented individuals and diverse perspectives.

Most prior human factors research has implemented frequentist approaches despite the advantages of Bayesian methods. In the frequentist paradigm of statistics, a hypothesis is tested by repeated experimental tests until a large enough sample size (i.e., "frequency") is achieved to make inferential statements. In Frequentism, the true long-run average accuracy should ideally be equal to the long-run average reported accuracy (Bayarri & Berger, 2004). This nature of unknown parameters underscores the key distinction between both approaches. Frequentists assume the parameter of interest is unknown but fixed. Meaning, it is assumed that in the population there is only one true population parameter (e.g., one true mean or one true regression coefficient). In the Bayesian perspective, it assumes subjective probability, that is, all unknown parameters are treated as uncertain and, as such, should be described by a probability distribution (Neyens et al., 2015). There are three essential components in Bayesian statistics (Bayes & Price, 1763; Stephen M. Stigler, 1986). The first component is the background knowledge on the parameters being modeled. This refers to the entirety of all known information before seeing the data and is reflected in the prior distribution. The larger the variance in the prior distribution, the more uncertain one is about the parameters of interest. The second element of Bayesian analysis is the information from the data itself, referred to as the likelihood distribution. Lastly, the third ingredient results from the combination of the prior and likelihood distribution, which is called the posterior distribution, or posterior inference. The posterior distribution balances one's prior knowledge with observed data, reflecting updated beliefs (Van de

Schoot et al., 2014). The three described components constitute Bayes' theorem (Equation 1). As seen in the formulation of Bayes' theorem, the posterior, or updated knowledge, of one's parameters of interest depends on its prior knowledge and current evidence. This theorem is displayed graphically in Figure 1.1.

$$P(A|B) = \frac{P(B|A) * P(A)}{P(B)} \quad \ldots(1)$$

Where:

- $P(A)$ is the prior knowledge
- $P(B)$ is the new information
- $P(B|A)$ is the likelihood the evidence true given the prior beliefs
- $P(A|B)$ is the new belief (i.e. posterior inference) true given the observed evidence

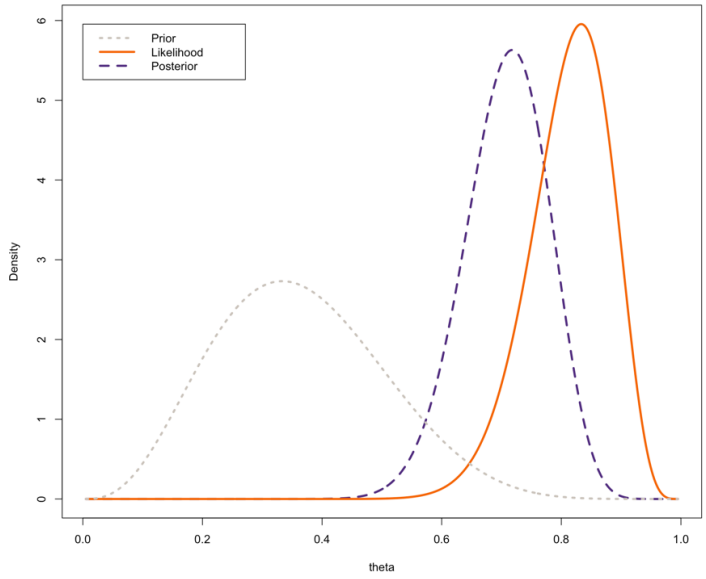


Figure 1.1: Graphical Representation of Bayes' Theorem with the Posterior Distribution Between the Likelihood and the Prior Distributions

As seen in the above figure, by updating the prior distributions from the data, the posterior is formed. In this example, the inclusion of additional data caused the posterior distribution to shift away from the prior. Yet, this distribution has wider tails than the likelihood distribution, reflecting the beliefs from the prior. The posterior distribution can be used to make predictions about future data through the posterior predictive distribution (Lazic et al., 2020). In Bayesian models, the posterior predictive distribution is used to assess the Bayesian predictive information criterion, which evaluates the expected log likelihood of the predictive distribution in cases where the true distribution is unknown (Ando, 2007). Moreover, this distribution is used to evaluate a model's predictive ability and quantifies uncertainty in predictions (Bickel, 2020; P. O. Lewis et al., 2014).

Applying Bayesian Analysis in HCI

Even though Bayesian analysis is gaining popularity across disciplines in STEM and psychology (Etz & Vandekerckhove, 2016; van de Schoot et al., 2017), classical frequentist inferences remains dominantly used in human-subjects research (Stunt et al., 2021; Szucs & Ioannidis, 2017b; Wagenmakers et al., 2018). A significant factor contributing to this is due to the absence of Bayesian statistics from the curriculum of mainstream graduate statistical learning (Wagenmakers et al., 2018). Despite the overcoming of the large computational costs associated with Bayesian analysis, it still requires an advanced understanding of advanced mathematical concepts and application of complex statistical computations, making the self-learning curve overly steep (Tso et al., 2021). More recent work in fields such as psychology and HCI, are calling for an increase in use for the Bayesian framework, citing the frequentist approach turns research into a

binary question (i.e., can we reject or fail to reject a null hypothesis?) (Kay et al., 2016; Tso et al., 2021). This can be problematic as obtaining a p-value less than .05 can still occur even when there is no true meaningful difference (Ioannidis, 2005; Szucs & Ioannidis, 2017b). Furthermore, published literature with false positive true H0 studies may inadvertently inflate the perceived effect size of non-existent or negligible effects (Button et al., 2013; Ioannidis, 2005, 2008; Schmidt, 1992, 1996; Song, 2005; Sterling et al., 1995). Replication of experiments and meta-analyses are proposed to mitigate errors in frequentist studies (e.g., the probability of falsely rejecting the null hypothesis) by aggregating the results of many studies finding the same phenomenon (Kay 2016), yet some researchers suggest this can persist the issue of overinflating effect sizes from such analyses (Nuijten et al., 2015; Szucs & Ioannidis, 2017b, 2017a). Since meta-analyses generally cannot incorporate unpublished negative findings (Sterling et al., 1995), they may inadvertently confirm false effects and result in a substantial exaggeration of measured effect sizes as demonstrated by Szucs and Ioannidis (2017a). Given this, Kay (2016) suggests the replication of studies and meta-analyses within the frequentist paradigm enhances the precision of effect estimates as being driven by top-down incentives. In contrast, Bayesian analysis can incorporate prior knowledge from similar studies investigating the same effects into its quantitative analysis, allowing for the accrual of knowledge and decreases the necessity for publishing separate meta-analyses. This bottom-up approach enhances effect estimates' precision as more knowledge is gained within the prevailing publishing framework (Kay et al., 2016). By aggregating data from many experiments through Bayesian methods, enhanced facilitation of the large-scale effort for better model

specifications in HCI research may be achieved (Gelman et al., 1995; Szucs & Ioannidis, 2017b).

Research Objective and Questions

The focus of this research employs a mixed methods approach to understand the effect of a healthcare chatbot's communication style (conversational or informative) and language style (technical or non-technical) on user experience. The quantitative approach implemented verified surveys and metrics to measure the healthcare chatbot's effectiveness, trust, and usability (Corritore et al., 2005; Kaleem et al., 2016; J. R. Lewis, 1995). Bayesian statistical models were used to assess the significant factors affecting these target variables. In the qualitative approach, we conducted semi-structured interviews and employed inductive thematic analysis (Braun & Clarke, 2021) to understand the design characteristics of the chatbot that positively and negatively impacted participants' experiences. This method evaluated user preferences and feedback through post-experience interviews to identify design implications for future healthcare chatbots, as well as to identify differences in user evaluations based on individual experiences. Previous literature has indicated that design strategies for chatbots significantly affect user experience. However, there remains a notable gap in the literature, specifically concerning healthcare-oriented chatbots, regarding information presentation styles. In particular, a chatbot's communication style and language style and its effect on the aforementioned outcome variables has yet to be explored. Therefore, the research questions of my thesis regarding healthcare-oriented chatbots for blood pressure and hypertension are:

Q1 – How does a healthcare chatbot's communication style affect user experiences?

Q2 – How does a healthcare chatbot's language style affect user experiences?

Q3 – What are the impacts of interactions between explanatory variables on the outcome measures?

Q4 – How do information presentation design characteristics positively and negatively impact user experiences?

Exploring these questions will contribute to the current gap in understanding the human-AI interaction experience in the context of the effect healthcare chatbots teaching about blood pressure and hypertension.

CHAPTER TWO:
RESEARCH DESIGN AND METHODOLOGY

To evaluate the effect of a healthcare chatbot's information presentation styles on a user's experience we implemented a mixed methods approach. This research was approved by Clemson University IRB (IRB#: 2023-0414). The study design, variables of interest, and analytical approaches are described as follows.

Study Design

This study used a 2x2 between-subjects design to investigate differences in communication style (conversational or informative) and language style (technical or non-technical language) for a healthcare chatbot. Participants were randomly assigned to each condition of the chatbot. To emulate a healthcare chatbot consistently across all participants and ensure internal validity, we employed a Wizard of Oz style methodology (Biro et al., 2023), where we simulate and control a chatbot agent. In this experiment, the healthcare chatbot could only answer questions pertaining to blood pressure and hypertension. Additionally, due to there being four distinct conditions for the study, we created four unique scripts for the chatbot (i.e., the 'Oz'), which represented a specific experimental condition. Participants were instructed to perform general knowledge seeking for health information pertaining to blood pressure and hypertension. They interacted with a chatbot named MedMind ChatGPT, which responded using pre-defined scripts designed to match the respective communication and language style for each condition. This name was chosen to enhance the perceived authenticity of the chatbot. Additionally, as of February 2024 the term "ChatGPT" is not trademarked, as indicated by the rejection of the trademark

application from the United States Patent and Trademark Office (USPTO) (Phillip, 2024), thereby allowing for its fair use. By utilizing this design, the study was able to emulate a conversational agent as the chatbot allowed for diverse user input style, had four unique interaction styles, and adapted responses based on users' conversation history and the context of their questions. Moreover, the aforementioned design was implemented as Kim et al.'s (2017) review noted the most common purpose of healthcare chatbots was to provide education and training pertaining to health-related subjects such as asthma, hypertension, mental health, breast cancer, and type 2 diabetes. By applying the procedure for participants to seek general knowledge gathering for a specific subject rather than emphasizing specific tasks to complete with the chatbot, we created an experiment that emulates the common use case of healthcare chatbots.

Experimental Conditions

As this was a 2x2 between-subjects study, there were four experimental conditions: 1) Conversational and Non-Technical, 2) Conversational and Technical, 3) Informative and Non-Technical, and 4) Informative and Technical. While all conditions of the chatbot presented the same information, the way it was presented varied by the condition. The conversational and non-technical chatbot was characterized by providing users with conversation flow options using a middle school reading level. Participants exposed to the conversational chatbot that used technical language, experienced the same communication style but at a reading level of high school or above. For users of the informative chatbot, the same words and reading level was used in both the non-technical and technical conditions, with differences observed in length of responses. In the informative condition,

participant received all information simultaneously, being prompted to generate more if they chose to continue learning about certain subjects, but without the ability to direct the direction of the chatbot's responses. This design approach ensured all participants had equal exposure to the same information for each question they asked, varying by the way the information was presented. The next section details how we created the chatbot scripts for the study.

Creation of the Pre-defined Chatbot Scripts

Responses to participants' possible questions about blood pressure built off the work of Biro et al. (2023). These responses were created, evaluated, and refined through their pilot testing and research on general blood pressure and hypertension information from online resources and books (Galton, 1973; N. M. Kaplan & Lieberman, 1979; Wade, 1975; Wilson & Childre, 2007). For the new quiz questions introduced in this study, we integrated this additional information into her pre-defined scripts, resulting in a variety of chatbot responses to questions about blood pressure and hypertension. For questions outside the scope of blood pressure, generic responses were formatted, such as, "I am sorry, I am unable to answer that question. Do you have another question about blood pressure?" A response such as this accounted for unanticipated questions and did not change between the four conditions of chatbot communication and language style.

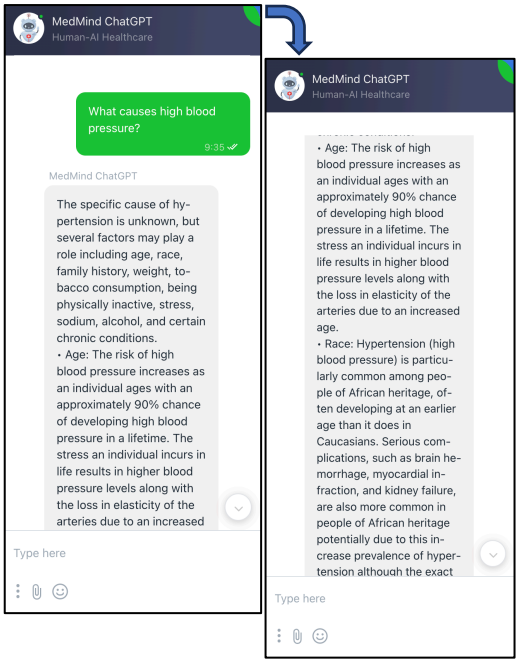
As there were four different conditions for which a participant interacted with a chatbot, we created four distinct pre-defined chatbot scripts. The creation of pre-defined scripts ensured that the interaction experience of each chatbot condition was distinct and consistent for all participants. We did this by first creating the scripts by technical and non-

technical responses. These were categorized by the Microsoft Word reading assessment feature as it uses the Flesch Kincaid readability tests. This test consist of the Flesch reading ease and the Flesch-Kincaid grade level to assess the reading difficulty of the written text (Alas et al., 2013). Created in the 1970s, these tests were used by the U.S. Navy military to assess technical manuals and are still implemented today, being a leading benchmark for calculating reading levels (Alas et al., 2013; Klare, 1976; Steinbrook, 2006). The chatbot conditions which had non-technical responses all had high reading ease and a reading grade level of 8 or below. As there were medical terms such as "systolic" and "diastolic" that are essential concepts to understand when learning about blood pressure, there were certain chatbot responses which could not be reduced lower than an 8th grade reading level. As such, this was used as a baseline for the maximum level for the non-technical responses. There were other responses in this condition which were classified as low as a 5th grade reading level. In contrast, the technical responses were crafted to have low reading ease value, with high school or above reading levels. Many of the chatbot's responses exceeded a 12th grade reading level in the technical condition, with some exceeding a grade level of 19 on the Flesch-Kincaid Grade Scale. These responses utilized more advanced language, as exemplified by the explanation of high blood pressure's negative effects, the technical chatbot articulated, "Over time, this hardening can have detrimental effects including increased risk of brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure." While the non-technical chatbot conveyed the same message with less sophisticated language, stating, "Over time, this hardening can have harmful effects. The effects include increased risk of stroke, heart attack, heart disease, and kidney failure." By segmenting the

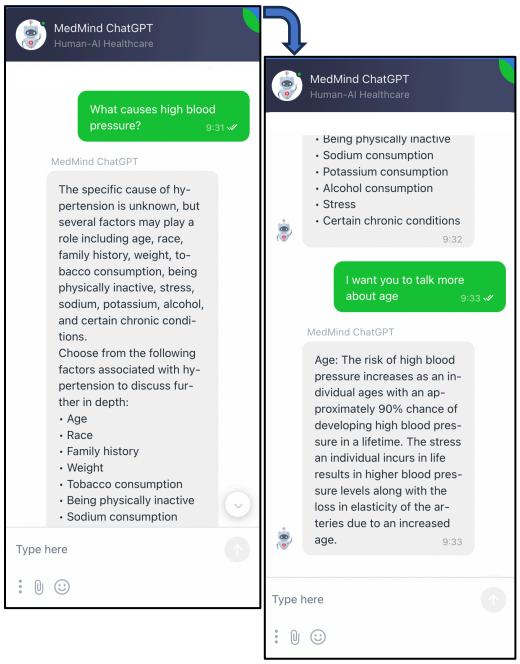
scripts by first technical and non-technical, we were then able to create scripts for the conversational and informative conditions.

The conversational condition was created by introducing prompts for further inquiry for various blood pressure and hypertension questions or by providing the user with the ability to control the conversation path. In this condition, a prompt of further inquiry could be, “Let me know if you would like me to provide important details for why hypertension is harmful, or if you want, you can ask another question.” While responses which allowed users to control the conversation path allowed users to choose from a list of, for example, the factors which are associated with hypertension such as age, race, family history, etc. These sequences also differed by language style. In the technical condition, the conversational chatbot prompted engagement by stating, “Please inform me if you need more information about diseases that can be found alongside hypertension, or if you prefer, ask a different question.” Conversely, in the non-technical condition, the chatbot used slightly simpler language, saying, “Please let me know if you want to learn more about other health problems that often come with high blood pressure, or if you'd rather ask a different question.” For the informative condition, there were no prompts of further inquiry and users did not have the option to control the direction of the chatbot’s response. For instance, in the information condition, the question “What causes high blood pressure?” elicits a lengthy responses detailing various causes, with the chatbot prompting the user if they desired additional information related to causes of high blood pressure. This same question in the conversational condition results in a list of causes for high blood pressure. The user is prompted to select a specific factor for further discussion, and the chatbot then

provides information on the chosen factor and presents the list again, allowing the user to select another cause of high blood pressure if desired. By approaching the experiment with this methodology, we created two distinct factorial levels for communication (conversational and informative) and language styles (technical and non-technical), each presenting information differently across the four conditions. Furthermore, it provides the opportunity for each participant to be presented with the same information as participants in different conditions of the study, preserving consistent opportunities for information seeking even across uniquely different interaction styles for the healthcare chatbot. Figure 2.1 and Figure 2.2 illustrate how communication styles vary across the four conditions. Figure 2.1 depicts the Informative and Technical condition (see Appendix C for script), as well as Conversational and Technical conditions (see Appendix D for script), while Figure 2.2 portrays the Informative and Non-Technical (see Appendix E for script) and Conversational and Non-Technical (see Appendix F for script) conditions.

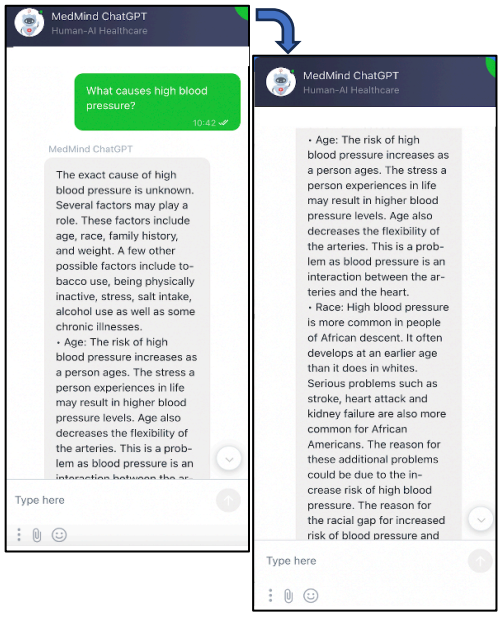


(A)

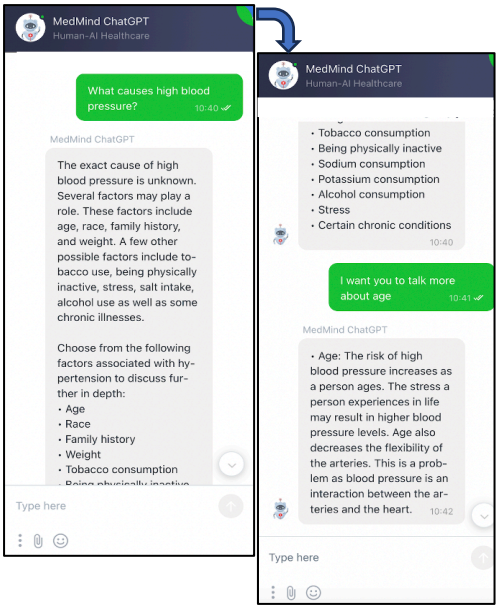


(B)

Figure 2.1: Informative and Technical (A) and Conversational and Technical (B)



(C)



(D)

Figure 2.2: Informative and Non-Technical (C) and Conversational and Non-Technical (D)

Apparatus and Experimental Setting

All studies were conducted in the Clemson EASt Lab, using three computers (two PCs and one Mac computer). One PC administered the surveys (demographic, usability, and trust), while another PC operated the website which participants interacted with the healthcare chatbot. This website was created in WordPress to emulate a healthcare patient portal. The website design was inspired by popular patient portals such as MyChart. We attempted to replicate the experience of such websites as this study involved engaging with a healthcare chatbot in patient portal. The healthcare chatbot resided in a conversation channel on the website, as seen in Figure 2.3, Jivochat (*Jivochat*, 2012) was the software used to employ the conversational channel and the 'Oz' controlled the chatbot through their Mac computer by responding through the Jivochat messenger system. The 'Oz', or co-experimenter, sat at a table in another room in the EASt lab and did not make it known to the participant that they were controlling the chatbot. The main experimenter sat next to the participant briefly as they engaged with the chatbot, and after confirming they understand the study's objective and do not have questions, they left the room as to not induce the Hawthorne effect on the participant (Festinger & Katz, 1953).

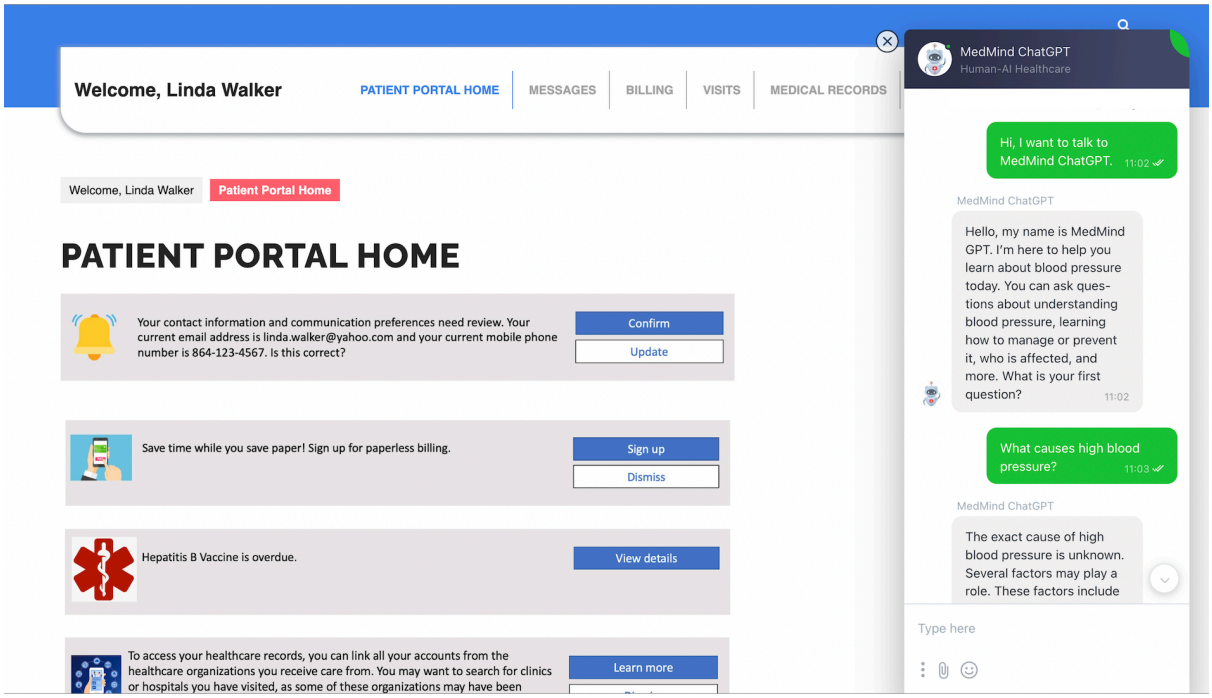


Figure 2.3: Apparatus of Healthcare Patient Portal

Independent Variables

This study controlled two independent variables (IVs), with both variables being fixed effects each with two levels. The first IV of interest was the communication style of the chatbot, which was defined as either conversational or informative. The other IV was the language style of the chatbot which was constructed to be technical or non-technical. Other random effects were collected such as the demographic information of the participant, the number of questions, and how long they interacted with the chatbot.

Dependent Variables

The outcome variables were the effectiveness, trust, and usability of the chatbot. The effectiveness of the chatbot was measured through a pre-posttest of blood pressure and hypertension information. The trust and usability of the chatbot were assessed through the

Trust survey by Corritore et al. (2005) and the Post-Study System Usability Questionnaire (PSSUQ) created by Lewis (1995). These operationalizations are described in the following section.

Variable Definitions and Operationalizations

This section details the variables collected during the study to articulate how they were gathered and measured. Furthermore, it will demonstrate how some variables were re-coded for the quantitative analysis. Table 2.1 presents all the collected variables and how they were measured.

Table 2.1: Variables Operationalized for the Quantitative Analysis

Variable	Operationalized
Effectiveness	Posttest - Pretest scores
Trust	Trust survey (Corritore et al., 2005)
Usability	PSSUQ (J. R. Lewis, 1995)
Health literacy	SAHL-E evaluation (Lee et al., 2010)
Number of 'I don't know' response by chatbot	Count via transcript evaluation
Number of questions asked by participant	Count via transcript evaluation
Time taken with chatbot	Time log
Rate of questions per minute	Number of questions / time taken
Frequency of conversation engagement	Number of times continued conversation / Number of possible continued conversations
Number of questions from the quiz asked	Number of asked quiz questions / total number of quiz questions
Number of questions not pertaining to the quiz	Count via transcript evaluation
Age	Demographic survey
Gender	Demographic survey
Education level	Demographic survey
Major	Demographic survey

Effectiveness

To assess the effectiveness of the chatbot's ability to teach about blood pressure, a pre-posttest was created. Participants took this test before and after interacting with the chatbot. For both the pre-test and the post-test, the same questions were given but with a different order to the questions. The creation of a measure for effectiveness evaluated how much participants improved their blood pressure knowledge from their interaction with the chatbot. Additionally, it specified if any participants had high pre-existing blood pressure

or hypertension knowledge in the pre-test scores, which could indicate potential bias in the analysis. This test was a modified version of a high blood pressure quiz from Biro et al. (2023), as it was created through online resources and books about blood pressure (Galton, 1973; N. M. Kaplan & Lieberman, 1979; Wade, 1975; Wilson & Childre, 2007). There were originally 16 questions but to increase the difficulty of the quiz, we removed questions that were deemed too easy and added new questions. This resulted in a new quiz containing 22 questions about blood pressure. The pre-posttest was developed by generating a pre-test with questions in one random order and a post-post with the questions in another random order. Both tests included identical questions, with the order of the questions and multiple-choice answers randomized. The pre-test is presented in Appendix A. Following the creation of the quiz, it underwent piloting with members of the Clemson Ergonomics & Applied Statistics (EASt) lab, as they participated in the pilot test of the full experiment. In this pilot testing, we were able to garner possible questions regarding blood pressure from participants as well as train lab members on how to be the 'Oz' and control the chatbot. Using the pre-posttest, the effectiveness of the chatbot was measured by the difference between the scores from these tests, where the number of questions correct on the post-test was subtracted by the number of questions correct on the pre-test.

Trust

The trust variable was measured using a web trust survey (Corritore et al., 2005) that was transformed to a chatbot trust survey by replacing the word 'website' with 'chatbot' in the survey instrument (see Appendix B for this change). For instance, the first question was changed from "The website provides truthful information" to "The chatbot

provides truthful information." The survey included a total of 15 questions, however, only the questions from the trust block of that survey were used to operationalize this variable. These questions were Question 14 and Question 15. The survey used a Likert scale, where strongly agree is 1 and strongly disagree is 7. We calculated the trust score by averaging the Likert scale for those questions to assess a participant's trust in the chatbot, where a trust value closer to 1 indicates high trust whereas values closer to 7 indicate low trust. After obtaining the trust scores for every participant, the variable was operationalized for analysis by separating the upper tertile from the bottom two-tertiles of trust scores. The upper tertile, assigned a value of 1, represented the highest 33% of scores, which were trust scores greater than or equal to 3.0. Conversely, the bottom two-thirds, coded as 0, consisted of scores below 3.0. The resulting binary variable, called low trust, indicated (1, participants were less trusting of the chatbot; and 0, participants were more trusting of the chatbot).

Usability

The usability variable was operationalized by the PSSUQ (J. R. Lewis, 1995) and uses a 7-point Likert scale for all 16 questions. The PSSUQ presents the Likert scale as strongly agree is 1 and strongly disagree is 7 and is calculated by averaging the Likert scale for each question to access a system's overall usability (J. R. Lewis, 1995). A PSSUQ value close to 1 indicates high usability whereas values closer to 7 indicate low usability. Usability was operationalized in two different ways. First, it was separated into a binary variable using a median split, with a median value of 2.1. Scores greater than or equal to 2.1 were coded as 0, while scores less than 2.1 were coded as 1. This was called median

split usability, and it indicated (1, participants perceived the chatbot as more usable, and 0, participants perceived the chatbot as less usable). The second method of operationalizing usability involved creating a binary variable by separating the usability scores at the upper quartile (Q3). When this variable is equal to 1, it represents usability scores greater than or equal to 2.4, with all other scores coded as 0. As such, when the variable is equal to (1, participants perceived the chatbot as less usable; and 0, participants perceived the chatbot as more usable), and it was named low usability. Both operationalizations were used for the analysis.

Hypotheses

Based on the research questions proposed in the introduction, this study posits several hypotheses. Firstly, we hypothesize conversational chatbots will result in increased effectiveness for participants to learn about blood pressure and hypertension. Additionally, we expect conversational chatbot to be identified as more trustworthy and with greater perceived usability. Moreover, we hypothesize the chatbots utilizing non-technical language styles will result in greater interaction efficacy as well as be identified as more trusted and more usable. We also anticipate that there may be interaction effects and other factors which influence the outcome variables in the models.

Determining Sample Size Through BFDA

To determine the effective sample size, we utilized Bayesian Factor Design Analysis (BFDA). This is a common technique used in Bayesian analysis because it allows for learning from the data, and the learning process can be repeated through indefinite iterations as more data is collected (Visser et al., 2024). This contrasts frequentist practices

as researchers typically decide on a fixed sample size before commencing data collection based on power analysis or rules of thumb sample sizes. BFDA, however, permits the use of flexible sampling plans, allowing for a technique called Bayesian Sequential Testing (BST) (Visser et al., 2024). BST utilizes iterative sampling and empowers researchers to define their own stopping criteria (Visser et al., 2024). In our experiment, we used R (version 4.3.2) to implement this methodology from the *BFDA* package (version 0.5.0). At the onset of our experiment, we decided to first collect data from 32 participants then perform BFDA to determine the value of our stopping criteria. By considering factors such as expected effect size of our alternative hypothesis, assuming an uninformative prior distribution, and defining the value of the Bayes Factor stopping criteria to be 10, we ran 1000 simulations of an experiment using BFDA. From the simulation results, it was observed that 20% of studies reached the predetermined stopping criteria of a Bayes Factor of 10 after the data collection of 40 participants, indicating strong evidence of our alternative hypothesis. This suggests that, despite assuming a small effect size of 0.2, our study could detect meaningful effects with after 40 datapoints have been collected. Upon this finding, we determined our target sample size would be (N=44) participants. Below in Table 2.2 the distribution of the participants by each condition is presented, with (n=11) participants in each condition of the 2x2 between subjects study. By utilizing BST to conduct iterative data sampling and BFDA, we effectively defined our required number of participants to result in strong evidence in favor of our alternative hypothesis.

Table 2.2: BFDA Informed Study Design and the Expected Number of Participants per Condition

		Chatbot communication style	
		Conversational	Informative
Language used by chatbot	Technical	11	11
	Non-technical	11	11

Participants

To participate in the study, specific eligibility criteria were established. The first criterion was that all participants had to be between the ages of 18 to 32 years old. As age influences communication and technology preferences (Clarke et al., 2020), the age requirement was implemented to control for the possibility of these age effects in this study. Moreover, being that the chatbot only communicated using the English language, all participants had to be able to read, write, and speak English. Additionally, as we were evaluating a healthcare chatbot disseminating health information, we wanted to ensure all participants had an adequate understanding of basic health literacy concepts to prevent health literacy from becoming a confounding variable. As such, all participants had to pass a Short Assessment of Health Literacy – English (SAHL-E) (Lee et al., 2010) to be included in the analysis. Establishing the eligibility criteria among participants enhances the study's internal validity. Participants were recruited from Clemson University and from the general population.

Procedure

To recruit participants, emails, flyers, and business cards were used, as well as through word of mouth. When interacting with potential participants, the experimenter verified that the participant's age was between 18-32 years old, as well as having the ability to read, write, and speak English. Upon validation that both of these conditions were true, the experimenter scheduled the participant for the study. When participants arrived to the lab, the experimenter greeted them and led them to the study area. The experimenter proceeded to provide the IRB approved consent information form (IRB2023-0414). After attaining verbal consent from the participants, the experiment began by instructing the participant to complete a demographic survey on Qualtrics. Following this, they completed the SAHL-E. The experimenter then proceeded to administer the paper pre-test, saying it was a questionnaire, on the health subject of blood pressure, instructing them to complete it to the best of their knowledge. After completion of the pre-test, the participant was informed on the scenario of the study. They were told to imagine they had a friend, Linda Walker, whose doctor instructed them to learn about blood pressure on their patient portal, and this friend had asked them (the participant) to help them with this task. In pursuit of this goal, they would utilize the healthcare chatbot, named MedMind ChatGPT, residing on Linda's online patient portal to learn about blood pressure and hypertension, aiming to gather as much knowledge as possible to assist in educating Linda Walker on this health subject. Participants were informed they could ask questions from the questionnaire (pre-test) or any other topics pertaining to blood pressure and hypertension, and that they had up to 15 minutes to interact with the chatbot. They were also informed they could end their

engagement with the chatbot whenever they felt they had reached a saturation of blood pressure and hypertension information. As we are simulating a chatbot through the Wizard of Oz methodology, participants were informed the chatbot was not "state-of-the-art", so response times might be slower compared to a system such as ChatGPT. Prior to engaging with the chatbot, the experimenter prepared an initial message for the participant to send MedMind ChatGPT. Once the participant was ready to interact, they would send this message to initiate the experiment and the health information seeking began. After the participant started the experiment with the chatbot, the experimenter left the room and the co-experimenter, stationed in another room, ran the chatbot as the 'Oz'. The participant had up to 15 minutes to learn as much as they desired about blood, and if they depleted their questions before 15 minutes, they were permitted to end the experiment. Following their information seeking task with the chatbot, the participant took the post-test on blood pressure. This was presented to the participant as another questionnaire, featuring the exact same questions as the pre-test but with the questions and multiple-choice answers arranged in a different order. The participant then proceeded to take the surveys on Qualtrics after the post-test. These surveys assessed the trustworthiness and the usability of the chatbot (Corritore et al., 2005; J. R. Lewis, 1995). Lastly, the participant participated in a semi-structured interview recorded on a Evida V618 device. They were asked questions related the features of the chatbot they liked or disliked and discussed how they would use this type of chatbot if it was implemented on their healthcare patient portal. Additionally, they were asked questions specifically about their perception of the chatbot's language and the syntax of communication, delving further into the aspects of the information presentation

of the healthcare chatbot. Upon this topic, participants ideated how they would like future chatbots and conversational agents to communicate health information (e.g., video, pictures, audio). Reflecting these future customization features, participants shared their views on how this technology can be improved to help them learn about healthcare topics. After completion of the semi-structured interview, the experimenter thanked the participant, provided a copy of the informed consent if desired, and emailed them a $10 Amazon gift card as compensation for participation in the study. Data collection began on September 29th, 2023, with our first participant, and it continued until January 26th, 2024, when we completed the last data collection session.

Quantitative Data Analysis Methodology

The approach taken to analyze the quantitative data was a Bayesian statistical analysis. We chose this approach as Bayesian analysis is an ideal methodological and philosophical approach to user-centered design and evaluation in HCI (Kay et al., 2016). We applied Bayesian analysis in the form of hierarchical Bayesian regression models to assess the factors which significantly affect our outcome variables. To do this, we used R as our statistical software for the analysis. The creation of the Bayesian hierarchical models was done using R2JAGS (version 0.7.1.1). R2JAGS utilizes the JAGS framework, or Just Another Gibbs Sampler, which is statistical software that employs Markov Chain Monte Carlo (MCMC) methods (Ross, 2022). It permits users to define Bayesian hierarchical models with a coding syntax similar to the BUGS (Bayesian inference Using Gibbs Sampling) language and uses a combination of Metropolis sampling, Gibbs sampling, and other MCMC algorithms (Ross, 2022). The components of an hierarchical Bayesian model

in JAGS model are: 1) load the data, 2) define the model's likelihood and prior, 3) compile the model in JAGS, 4) simulate values from the posterior distribution, and 5) check diagnostics and summarize simulated values (Ross, 2022). For the three outcome variables of effectiveness, trust, and usability, we created three separate hierarchical Bayesian regression models. The outcome measure for the chatbot's effectiveness used a Bayesian negative binomial hierarchical regression model. While the outcome measures of trust and usability both implemented Bayesian Bernoulli hierarchical regression models. The algorithms were trained with a total of 100,000 iterations, and the first 50,000 iterations were discarded as burn-in. A thinning parameter was applied to mitigate autocorrelation in the MCMC samples, retaining every 50th iteration of the MCMC chain. Parameter significance can be assessed by examining the credible set of the estimated coefficients. If the credible set does not include zero, then the corresponding parameter is considered statistically significant (Hespanhol et al., 2019; Neyens et al., 2015). On the other hand, if a parameter's coefficient does include zero, then that parameter is not deemed statistically significant (Hespanhol et al., 2019; Neyens et al., 2015). The credible set, otherwise known as the credible interval, is generated from the posterior distribution in Bayesian analysis. It represents the region of parameter values that are believed to be plausible given the observed data and the prior information. In this regard, the credible set can be described as a probabilistic measure of uncertainty related to unknown parameters in a model. The ability to provide a credible set enables researchers to make inferences about the parameter's true value based on the provided data and prior beliefs. While it can appear similar to frequentist confidence intervals, their statistical definition and interpretation

differ. A confidence interval, with an $\alpha = .05$, is seen as a long-run approximation that a sampled confidence interval from a given population will encompass the true parameter estimate 95% of the time (Congdon, 2007; Neyens et al., 2015). In contrast, a 95% credible set is understood as an interval containing the true parameter with 95% certainty, considering the available data (Congdon, 2007; Neyens et al., 2015).

Specifying the Priors in the Hierarchical Bayesian Regression Models

As stated in the previous section, hierarchical Bayesian regression analysis was employed to model the three outcome variables of effectiveness, trust, and usability. A critical aspect of this analysis involves the specification of the priors, as the priors, when combined with the data, determine the posterior distribution. Researchers define priors on previous knowledge or personal beliefs. It is worth noting that the selection of priors can be a controversial topic (Gelman, 2008), being criticized due to its subjectivity and can greatly influence the results, particularly in small-sample studies. To guide the specification of priors in this study, useful guidelines provided by Bayesian researchers for different models and data types were consulted (Cowles, 2013; Gelman, 2002, 2006, 2019; Gelman et al., 1995; Kass & Wasserman, 1996; Tso et al., 2021).

Given the novelty of investigating information presentation styles of healthcare chatbots, existing knowledge applicable to the model is lacking. Consequently, any value between the range of $-\infty$ and $+\infty$ is equally likely for the model parameters. For this reason, the prior for the intercept, μ_α, and the mean value of each parameter, μ_{β_i}, are specified as the following in Equation 2.

$$\mu_\alpha \sim N(0.0, 10^5) \quad \ldots(2)$$
$$\mu_{\beta_i} \sim N(0.0, 10^5)$$

Assuming this state of uncertainty for the prior distributions is commonly referred to as a noninformative prior distribution (Van de Schoot et al., 2014) because a researcher does not have a specific hypothesis about a parameter's true value. Moreover, to specify a noninformative distribution for the standard deviation of the model's intercept, σ_α , and parameter values, σ_{β_i}, a noninformative uniform distribution (Equation 3) was implemented (Cowles, 2013; Gelman, 2006).

$$\sigma_\alpha \sim U(0.0, 10) \quad \ldots(3)$$
$$\sigma_{\beta_i} \sim U(0.0, 10)$$

Utilizing these hyperparameters, μ and σ, we operationalized the intercept, α, and each parameter, β_i, by drawing from a noninformative normal distribution as seen below (Equation 4).

$$\alpha \sim N(\mu_\alpha, \sigma_\alpha^2) \quad \ldots(4)$$
$$\beta_i \sim N(\mu_{\beta_i}, \sigma_{\beta_i}^2)$$

The above distributions represent a hierarchy as β_i and α cannot be operationalized before they are informed by their preceding non-informative hyperparameter priors. This invokes another important factor about implementing non-informative in Bayesian analysis

because in some cases, the utilization of non-informative priors may yield scientifically implausible posterior values (Gelman, 2002). Therefore, it is important to evaluate a model's results to ensure its sensibility when applying non-informative prior distribution in hierarchical Bayesian models.

Specifying the Likelihood Function in the Hierarchical Bayesian Regression Models

The previous section described the formulation of priors in Bayesian analysis. In general, the use of informative priors often leads to results similar to frequentist maximum likelihood estimation, given that the formulation of the model are the same (Tso et al., 2021). In a Bayesian approach, the likelihood function determine the probability of observing a result given the value of the parameters. In a Bayesian hierarchical approach, the likelihood of observing an event (e.g., the participant is less trusting of the chatbot) would be calculated for every data point, in this case, every participant. In this example, a Bernoulli distribution is chosen because it represents a participant's single interaction with a chatbot, reflecting an event of with two outcomes (1, being less trusting of the chatbot; and 0, not being less trusting of the chatbot). A critical component of the likelihood function is the linear predictor, which is a linear combination of coefficients and explanatory variables used to predict the value of the dependent variable. Its simplified form is presented in Equation 5, while the expanded form, used in the Bernoulli hierarchical regression model to predict a participant's trust level, is detailed in Equation 6. Specifying the linear predictor results in the full formulation of the likelihood function of the Bernoulli model (Equation 7).

$$\theta_i = \alpha + (\beta_i * X_i) + \varepsilon \quad \ldots(5)$$

$$\begin{gathered}\theta_i = \alpha + \\ \beta_1 * (Conversational\ Style) + \\ \beta_2 * (Non - Technical\ Language) + \\ \beta_3 * (Median\ Split\ Usability) + \\ \beta_4 * [(Non - Technical\ Language * Median\ Split\ Usability)]\end{gathered} \quad \ldots(6)$$

$$y_i \sim Bernoulli(p_i) \quad \ldots(7)$$

$$p_i = \frac{1}{(1 + e^{-\theta_i})}$$

$$\begin{gathered}\theta_i = \alpha + \\ \beta_1 * (Conversational\ Style) + \\ \beta_2 * (Non - Technical\ Language) + \\ \beta_3 * (Median\ Split\ Usability) + \\ \beta_4 * [(Non - Technical\ Language * Median\ Split\ Usability)]\end{gathered}$$

Where:

- y_i represents the observed outcomes
- X_i represents the explanatory variables
- β_i represents the weights of the explanatory variables
- α is the intercept
- θ_i is the linear predictor, given by $\theta_i = \alpha + (\beta_i * X_i) + \varepsilon$
- p_i is the probability of success for each observation, i
- ε is the error term

Example Formulation of a Hierarchical Bayesian Regression Model

Given the explanation for the two critical components to calculate the posterior distribution, the combination of the prior specifications and the likelihood formulation combines to create the hierarchical Bayesian model. This example illustrates a Bernoulli hierarchical Bayesian regression to model if a participant is less trusting of the healthcare chatbot (Equation 8). R code for the hierarchical Bayesian formulation is also presented in Appendix G.

$$y_i \sim Bernoulli(p_i) \quad \ldots(8)$$

$$p_i = \frac{1}{(1 + e^{-\theta_i})}$$

$$\theta_i = \alpha + \beta_1 * (Conversational\ Style) + \beta_2 * (Non - Technical\ Language) + \beta_3 * (Median\ Split\ Usability) + \beta_4 * [(Non - Technical\ Language * Median\ Split\ Usability)]$$

$$\alpha \sim N(\mu_\alpha, \sigma_\alpha^2)$$

$$\beta_1 \sim N(\mu_{\beta_1}, \sigma_{\beta_1}^2)$$

$$\beta_2 \sim N(\mu_{\beta_2}, \sigma_{\beta_2}^2)$$

$$\beta_3 \sim N(\mu_{\beta_3}, \sigma_{\beta_3}^2)$$

$$\beta_4 \sim N(\mu_{\beta_4}, \sigma_{\beta_4}^2)$$

$$\mu_\alpha \sim N(0.0, 10^5)$$

$$\mu_{\beta_1} \sim N(0.0, 10^5)$$

$$\mu_{\beta_2} \sim N(0.0, 10^5)$$

$$\mu_{\beta_3} \sim N(0.0, 10^5)$$

$$\mu_{\beta_4} \sim N(0.0, 10^5)$$

$$\sigma_\alpha \sim U(0.0, 10)$$

$$\sigma_{\beta_1} \sim U(0.0, 10)$$

$$\sigma_{\beta_2} \sim U(0.0, 10)$$

$$\sigma_{\beta_3} \sim U(0.0, 10)$$

$$\sigma_{\beta_4} \sim U(0.0, 10)$$

Model Diagnostics

Evaluating Bayesian statistical models requires determining if the models have converged to a stationary distribution. The JAGS framework uses a combination of Gibbs Sampling, Metropolis Hastings, and other MCMC techniques to reach convergence for the model's parameters (Ross, 2022). Once a model converges, it remains in a stationary distribution and moves (i.e., mixes) throughout the parameter subspace indefinitely. However, there are instances when the model fails to converge to a stationary distribution, resulting in mixing which follows abnormal trends in the sample space. A popular method described by Rubin (1981) for assessing convergence is the use of trace plots, which illustrate conditional estimates over a large range of plausible heterogeneity values. This method offers valuable insight into the inner workings of the model (Röver et al., 2024). Convergence can be evidenced by a trace plot mixing around the mode of the distribution, whereas signs of non-convergence include observable trends in the sample space (Gunn-Sandell et al., 2024). Another way to assess convergence is through histogram plots of the parameters generated in the posterior distribution. A converged model will display a histogram with a clear, single distribution. Conversely, multimodal distributions in the histograms – indicated by more than one local maxima or distinct peaks – suggest non-convergence (Gunn-Sandell et al., 2024). Furthermore, evaluating the independence of the samples generated by the MCMC algorithm is a critical aspect to ensure convergence. This can be achieved through autocorrelation plots (Gu & Sun, 2020; Hogg & Foreman-Mackey, 2018). High autocorrelation indicates poor mixing of the MCMC (Gu & Sun, 2020) and suggests non independence in the sample space, which can result in a model that

has not converged. Diagnostics were assessed for all models but will only be shown for the effectiveness model.

Qualitative Data Analysis Methodology

To analyze the semi-structured interview, we first employed Otter.ai for interview transcription (*Otter.Ai*, 2016). Upon initial creation of the interview transcripts, the experimenter validated the transcripts by listening to the interview and correcting mistakes from the generated Otter.ai transcript when necessary. After all the transcripts had been validated, they uploaded the transcript to Atlas.ti for coding analysis (*Atlas.ti*, 1993). The methodology the coding analysis utilized was inductive thematic analysis (Braun & Clarke, 2021). In this approach, the experimenter derived meaning and identified significant themes in the underlying data. The process began with the examination of the interview transcripts to gain comprehensive understanding of the data. Next, the experimenter analyzed the transcripts to develop codes related to participants' experiences and ideations regarding how healthcare chatbots can be improved. Following this, the broader research team evaluated these codes, leading to the discerning of initial themes which aligned with prevalent patterns in the data that were then refined throughout the analysis of the interviews. While our statistical analysis focuses on the comprehensive interaction experience with the CA, our qualitative analysis specifically focuses on only one controlled variable: the communication style (conversational or informative). The analysis does not include an exploration of the language style (technical or non-technical).

CHAPTER THREE:
QUANTITATIVE RESULTS

Descriptive Statistics

In total, we recruited 45 participants for the study, but one participant's data was removed because they failed the SAHL-E. As a result, our analysis included data from (N=44) participants, with (n=11) participants in each condition based on the assessment from the BFDA. Table 3.1 presents the descriptive characteristics of the participants in the study. The mean age of the participants was 26.1 years old (SD=3.2). The participant demographics included an equal number of males of males (50.0%) and females (50.0%). The majority of participants were graduate students (75.0%) with undergraduate students (13.6%) and individuals not currently enrolled in university (11.4%). Furthermore, 77.3% of the students were studying or had obtained a degree(s) in STEM fields, while the remaining 22.7% were studying or held a degree(s) in non-STEM fields of study. Additionally in the demographic questionnaire, participants were asked questions related to their experience with chatbots. Nearly all of the participants (91.0%) have interacted with ChatGPT in the past. In terms of the frequency of chatbot use in general, half of the participants utilize chatbots weekly (50.0%), nearly half seldom or never use chatbots (45.0%), and a small portion use chatbots all the time or daily (5.0%). In our study, the average time of interaction with the healthcare chatbot was 12 minutes and 22 seconds (*SD*=2 minutes and 26.3 seconds).

Table 3.1 Characteristics of Study Participants (N=44)

Characteristic	Participants, N (%)
Age	M=26.14, SD=3.20
Sex	
Male	22 (50)
Female	22 (50)
Race	
Asian	12 (27.3)
Bi- or Multi-Racial	9 (20.5)
Black or African American	2 (4.5)
Caucasian	21 (47.7)
Education, highest degree obtained	
High School/GED	6 (13.6)
Bachelors	19 (43.2)
Master's	18 (40.9)
Doctorate	1 (2.3)
Education, area of study	
STEM*	34 (77.3)
All other majors	10 (22.7)
Year in school	
Undergraduate student	6 (13.6)
Graduate student	33 (75)
Not applicable	5 (11.4)
Frequency of chatbot use, in general	
All the time or daily	2 (5.0)
Weekly	22 (50.0)
Seldom or never	20 (45.0)
Used ChatGPT	
Yes	40 (91.0)
No	4 (9.0)
Time of interaction (min.)	M=12.37, SD=2.44

Note: STEM* is defined as Science, Technology, Engineering, and Math

Effectiveness

The effectiveness of the chatbot was measured through the pre-posttest about blood pressure and hypertension, where the difference between the post-test and pre-test was the effectiveness score. On average, participants improved by 4 questions (M=4.0, SD=2.9), with a variance, s^2, of 8.2. As the effectiveness score was not normally distributed as seen in Figure 3.1 and Figure 3.2, a negative binomial model was chosen to model this parameter. This model assumes an overdispersion of a random variable, *Y*, meaning the $Var(Y) > E(Y)$ (Johnson et al., 2022). For the effectiveness score, the sample mean, $\bar{x}$, is equal to 4.0 and the sample variance, s^2, is equal to 8.2, thus the $s^2 > \bar{x}$. For this reason, a negative binomial model was chosen for the Bayesian hierarchical regression to predict the effectiveness of the chatbot.

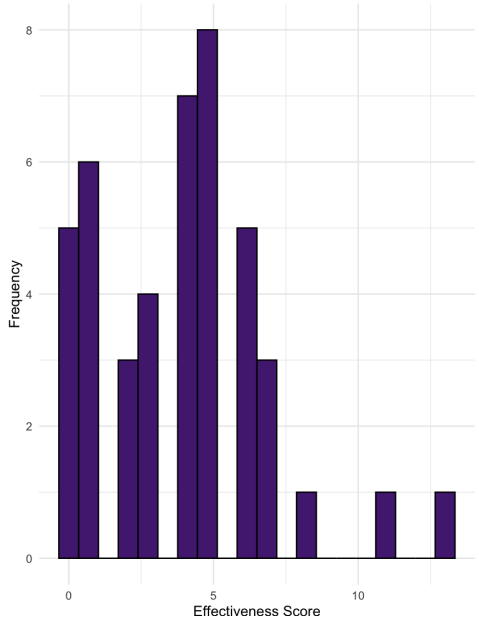


Figure 3.1: Histogram of Effectiveness Score

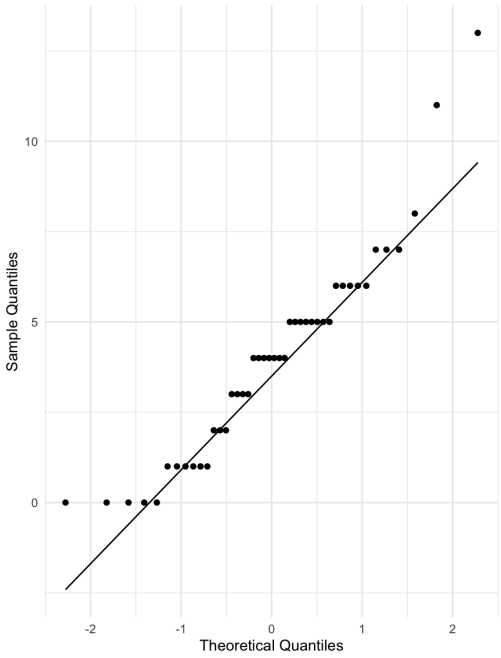


Figure 3.2 Q-Q Plot for Effectiveness Score

As described in Chapter 2, the fixed effects controlled in the study were the communication style (conversational vs. informative) and language style (technical language vs. non-technical language). Additionally, a usability-related explanatory variable and interactions between with the usability-related measure were included in the model to account for the potential effects that other variables had on the effectiveness outcome variable. The communication style variable was coded as (1, communication style was conversational; 0, communication style was informative), whereas the language style variable was coded as (1, language style was non-technical; 0, language style was technical). The usability variable was recoded to be a binary variable that identified lower usability scores such that a usability score less than '2.4' was coded as 0, and usability

scores greater than or equal to '2.4' were coded as 1. An $\alpha = .05$ was used to assess significance in the 95% credible set.

The Bayesian Negative Binomial Hierarchical Regression model implemented to investigate the factors significantly impacting a healthcare chatbot's effectiveness to disseminate blood pressure and hypertension information is seen in Table 3.2. This model found the interaction effect between a conversational chatbot and having low perceived usability resulted in a significant mean increase of 2.13 (95% CS: 0.97 to 3.51). Moreover, for participants that perceived the chatbot with lower usability, there is estimated mean decrease for the effectiveness score of -1.92 with a credible set from -3.17 to -0.92.

Table 3.2: Bayesian Negative Binomial Hierarchical Regression Model for Predicting Effectiveness

Parameter	Estimate	SD	Lower 95% CS	Upper 95% CS
Intercept	1.47	0.18	1.12	1.79
Conversational style	-0.27	0.22	-0.70	0.15
Non-technical language	0.21	0.20	-0.17	0.61
Low usability	-1.92	0.59	-3.17	-0.92
Conversational style*Low usability	2.13	0.65	0.97	3.51
SD of intercept	4.97	2.87	0.29	9.75
SD of error	2.69	0.14	2.56	3.05
Dispersion parameter	13.52	11.23		
Deviance	201.63	3.43		
DIC	207.50			
pD	5.90			

Model Evaluation

As detailed in the methods, assessing convergence of the MCMC algorithm is a crucial component in order to make inferences from Bayesian models. As seen Figure 3.3, the models parameters mix around a single mode, indicating convergence. Additionally, the posterior distribution of model's parameters (Figure 3.4) demonstrate distinct, unimodal distributions. Furthermore, there is no indication of high correlation within the model, implying independent samples drawn from the posterior distribution. The autocorrelation plots are provided in Appendix H, shown in Figure H1.

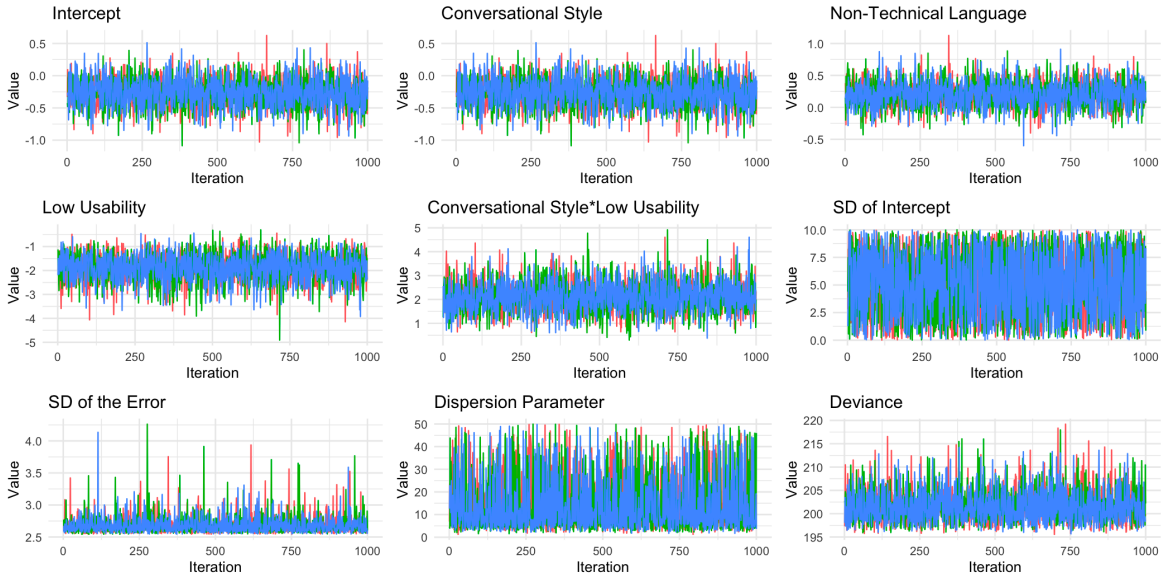


Figure 3.3: Trace Plot of the Parameters in the Effectiveness Model

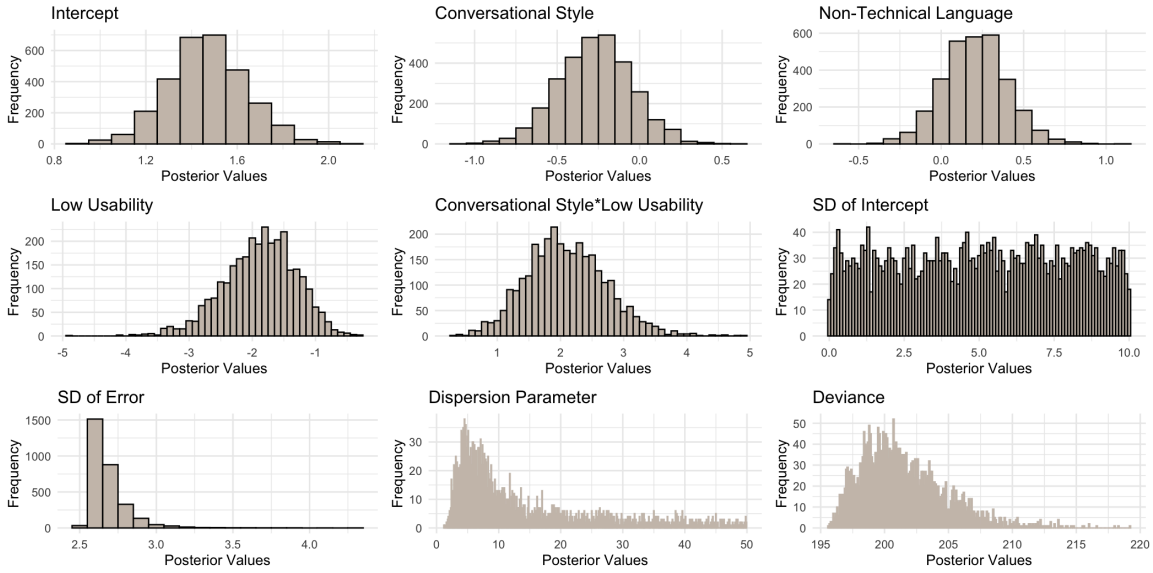


Figure 3.4: Histogram of the Posterior Distribution for the Parameters in the Effectiveness Model

Trust

A participant's trust in the healthcare chatbot was assessed by taking the average score from the Likert scale questions 14 and 15 in the Trust survey. These questions were specifically related to trust, while other questions in this survey reflected the chatbot's perceived ease of use, risk, honesty, and predictability. By focusing solely on trust-related questions, we obtained a specific assessment of trust. The binary variable was defined such that an average trust score greater than or equal to 3.0 was coded as 1, while a score less than 3.0 was coded as 0. Thus, when the binary trust variable is 1, the participant were less trusting of the chatbot; and, when the binary variable is 0, the participant were more trusting of the chatbot.

A Bayesian Bernoulli Hierarchical Regression model was created to assess the significant factors impacting the log-odds of participants' trust in the healthcare chatbot

(Table 3.3). Factors associated with decreased likelihoods of being less trusting were if the chatbot was found to be chatbot more usable (AOR=0.03, 95% CS 0.00 to 0.36) and if the chatbot used non-technical language (AOR=0.11, 95% CS 0.01 to 0.97). However, if the participant engaged with the conversational chatbot, this was significantly associated with a higher likelihood of being less trusting of the chatbot (AOR=7.17, 95% CS 1.46 to 43.82). Moreover, the interaction effect of the chatbot's use of non-technical language and the chatbot being identified as more usable also resulted in higher likelihoods being less trusting of the chatbot (AOR=121.51 , 95% CS 3.97 to 7863.60).

Table 3.3: Bayesian Bernoulli Hierarchical Regression Model for Predicting Lower Trust

Parameter	Estimate	SD	Lower 95% CS	Upper 95% CS	Odds ratio 95% CS
Intercept	-0.50	0.77	-2.04	0.96	
Conversational style	1.97	0.88	0.38	3.78	7.17 (1.46, 43.82)
Non-technical language	-2.25	1.21	-4.85	-0.03	0.11 (0.01, 0.97)
Median split usability	-3.58	1.57	-7.07	-1.03	0.03 (0.00, 0.36)
Non-technical language* Median split usability	4.80	1.99	1.38	8.97	121.51 (3.97, 7863.60)
SD of intercept	5.08	2.91	0.28	9.78	
SD of error	0.43	0.02	0.41	0.46	
Deviance	48.83	3.45			
DIC	54.80				
pD	6.00				

Usability

The usability of the healthcare chatbot was assessed by calculating the average score of the Likert-scale responses in the PSSUQ. This determines the perceived overall usability in terms of the chatbot's information quality, interface quality, and system usefulness (J. R. Lewis, 1995). A binary variable was created for the usability assessed of the chatbots, with PSSUQ scores of less than 2.1 coded as 1, and PSSUQ scores greater than or equal to 2.1 coded as 0. Thus, when the binary usability variable was 1, it indicated that the participant found the chatbot more usable, and when the binary usability variable was 0 that indicated the participant found the chatbot less usable.

A Bayesian Bernoulli Hierarchical Regression model was created to determine the factors significantly affecting the log-odds of a participant perceiving the chatbot with higher usability (Table 3.4). In this model, if participants engaged with the conversational chatbot (AOR=6.30, 95% CS 1.21 to 38.86), participants were significantly more likely to perceive the chatbot as having higher usability. Moreover, when participants reported the chatbot as being less trustworthy (AOR=0.01, 95% CS 0.00 to 0.18), it was associated with an increased likelihood of not finding the chatbot to be high usability. While the chatbot's use of non-technical language did not significantly affect the likelihood of finding it more usable, the interaction between non-technical language and being less trusting of the chatbot (AOR=424.11, 95% CS 11.02 to 34544.37) significantly increased the likelihood of perceiving the chatbot as more usable.

Table 3.4. Bayesian Bernoulli Hierarchical Regression Model Predicting Higher Usability

Parameter	Estimate	SD	Lower 95% CS	Upper 95% CS	Odds ratio 95% CS
Intercept	0.26	0.62	-0.97	1.49	
Conversational style	1.84	0.89	0.19	3.66	6.30 (1.21, 38.86)
Non-technical language	-1.64	0.94	-3.65	0.11	
Low trust	-4.47	1.62	-8.10	-1.71	0.01 (0.00, 0.18)
Non-technical language* Low trust	6.05	2.06	2.40	10.45	424.11 (11.02, 34544.37)
SD of intercept	4.93	2.89	0.30	9.70	
SD of error	0.45	0.01	0.44	0.48	
Deviance	53.81	3.34			
DIC	59.40				
pD	5.60				

CHAPTER FOUR:
QUALITATIVE RESULTS

We conducted semi-structured interviews (N=44) following the interaction with the healthcare chatbot. The average duration of the interviews was 14.84 minutes (SD=3.91). After conducting the interviews with participants' about their interactions with the chatbot, we employed inductive thematic analysis to gain insight their experiences. As stated in the methods, the inductive thematic analysis (Braun & Clarke, 2021) conducted in this study specifically analyzes participants' experiences in regards to the communication style independent variable.

Conceptualized Themes from the Interviews

The initial themes encompassed: 1) difficulty with learning healthcare related information, 2) desiring for the ability for chatbots to display information in their preferred way, 3) appreciating aspects of the various chatbots' communication style, 4) user experience pertaining to all chatbot conditions, and 5) suggestions for improvement for healthcare chatbots. After reflexive analysis, four final themes were conceptualized. The first three are: 1) improving overall user experience for healthcare chatbots, 2) enhancing user experience through human-like chatbot interactions, 3) excessive information hindering user engagement. Although these were the general themes conceptualized across the conditions, there were discrepancies between these three themes, leading to the fourth and final theme: 4) processing fluency bias for the presentation of information by healthcare chatbots. This final theme is the main finding from the inductive thematic analysis and will be the main focus for the discussion of the qualitative results.

Improving Overall User Experience for Healthcare Chatbots

The upcoming section details various findings regarding perceptions of the overall design and user experience across all conditions of the chatbot. These findings are summarized in Table 4.1. In this section, we specifically detail aspects of user interface preferences, the importance of transparency in a healthcare chatbot's sources and functionality, and the desire for empathetic and emotionally attuned conversations. Furthermore, this section introduces participants' ideations for various modalities of communication and for the personalization of interaction sequences. This finding is associated with the larger theme of a processing fluency bias which will be analyzed in the final section of the qualitative analysis.

Table 4.1: Overall Design and User Experience

Characteristics		
User Interface Preferences	**Source Verification and Clear Functionality**	**Appreciating Response Strategy Variety**
Disliked response auto-scroll	Hyperlinks to website for more information (YouTube, WebMD, etc.)	The conversational aspects of chatbot
Increased chat window size	Transparency of chatbot functionality	The ability to guide the conversation
Desiring web-based chat interface	Hospital sponsored healthcare chatbot	The ability to chunk information
Enhanced Cognitive Compatibility	**Personalized Interaction Experience**	**Emotionally Attuned Conversations with Contextual Understanding**
Responses incompatible with mental model	Customize how chatbots communicates with users	Desiring human-like conversations
Responses are too long	Ability to infer what/how to display information	Comforting/soothing in serious contexts
Desiring ability to reduce information complexity	Increased interactivity with chatbot	More detailed or specific depending on the context

User Interface Preferences

With respect to the user interface design, the participants expressed discontent with the size of the chatbot window and the response auto-scroll implemented in the study. Moreover, participants generally reported disliking when the chatbot made multiple responses in a single interaction. One participant summarized this by saying, "I disliked when it tried to do multiple messages at once. Especially because the box itself is thin but long... when another one popped up, it took the text very far away, and I had to keep scrolling back up" [P14]. Furthermore, when considering the design of the chatbot, the participants expressed an option to have a dedicated web-based chat interface when communicating to the healthcare chatbot, citing its ability to "structure and present" [P33] health information.

Source Verification and Transparency in Functionality

There was also an expressed desire to have healthcare sponsored chatbots. P16 said, "it might be more reputable if it was actually like [a] health specific chatbot… sponsored by a doctor's office, or like a health portal. [I would] believe that more than going to Google." Another mentioned how a healthcare specific chatbot would have more expertise than general chatbots because OpenAI's "ChatGPT is more integrated [from] different information [sources]… For healthcare, I will prefer a more expertise [chatbot]" [P32]. Emphasizing the importance of context-specific chatbots, they went on to compare chatbots to university students "having different majors and you are the expert on your own major or even smaller research area, I think for chatbots it should be the same thing" [P32]. Another participant, P26, even said he would trust a healthcare sponsored by chatbot such

as a “Harvard Health Sciences chatbot” because of “the accountability mechanisms at Harvard, hopefully protecting our data and overlooking what it is telling me and constantly improving its process.” Along with this, participants expressed a desire for clear transparency in the chatbot functionality as it is important to “know what is the source [and] where is information coming from” [P5]. The transparency about sources and clear communicating a chatbot’s functionality is, in P3’s words “the first thing to have a good communication of the platform. To say what [is] the type of service, type of answer, that you can get from it… having that information upfront so you will know what to trust.” To enhance such features, displaying “links to some YouTube video… [but] not only to YouTube, but maybe having a resource to go more in depth. [To] have the traceability of the source” [P3]. For P30, this was especially important to trust the chatbot, saying “for a person like me, I have no experience on the medical part and because it has something to do with our health, we should be a little careful. This chatbot [should] recommend the sources that it is using.”

Empathetic and Emotionally Attuned Conversations

When discussing specific healthcare conversation contexts, participants emphasized the importance of communicating with empathy and care in specific scenarios. Expressing the need for chatbots to be more than “just want[ing] to collect the data… especially in the healthcare field... [if] you just collect the data [that] you [have] pain, but you did not say, like ‘I'm sorry to hear’” [P31]. They went on to express the importance of “showing people [the chatbot is] caring about you… So people will feel like this robot is more like a friend” [P31]. For some participants this functionality is significant for

healthcare chatbots because, for example, facts about the factors associated with high blood pressure "like obesity is very cut and dry. If I had an option [for the chatbot] to be more friendly about this, I would go more friendly… more care and empathy" [P38]. Going deeper about having emotionally attuned conversations with healthcare chatbots, P28 made this point, stating, "there is a certain element that could be there… where the AI can kind of like sense what your position is and… maybe add in little elements to help answer your question better." This could be beneficial as people "go on, like, WebMD and look something up, sometimes whatever [they] find can be really scary at first" [P43]. Searching for health information using this method, "a lot of people get fear… think[ing] they have cancer all the time. So something more intuitive can be like, 'hey, these are the facts, here is what the next steps of what you need to do [are]'" [P28]. Under certain contexts, this type of communication style could help "soften the blow" [P28] for some users engaging in health information who get "fear [when] looking up their symptoms on the internet" [P43]. From P31's perspective, they summarized this need by stating, "human-centered [AI], I feel, is caring compared to smart" [P31]. It is important to note that not all users desired to have chatbots with functionalities of empathy and emotions, with one saying, "I would trust it with the facts… but not having empathy or understand[ing] emotions" [P23].

Multimodal Information Presentation and Personalization of Chatbot Interactions

There was a general desire to reduce the information complexity and be able to enhance interactivity by customizing how chatbots interact with users. Participants suggested different modalities of communication as a means to accomplish this, as one participant suggested "some people prefer text, some people prefer audio, [others] prefer

audio and video together, right? I like... videos... [Also], I need to hear, but [for] explanation... the ideal chatbot... can give a video with audio cues, explaining... high blood pressure" [P18]. This led to participants to desire for the alignment of their mental model for how healthcare chatbots present information. P12 said, "my type of intelligence… is using my sense of sight, I'm very visual and very dynamic [and] kinesthetic." Participants also suggested aligning their mental model for learning health information by personalizing chatbot interaction sequences. P14 emphasized this importance by stating the need for a chatbot to understand what and how they wanted to learn before delving into specific topics, stating, "for me, at least, when the first thing I got [from MedMind ChatGPT] was just a lot of information. It's a lot to process at once. At least start off small [with] initial conversations." They went on to compare chatbot responses to internet searches, saying "some AIs are very blind and will pop up the first Google search when it is the third tab down that is the true answer...so being able to [give] it more information... so it can adjust its parameters" [P14]. In this context, they are suggesting that although responses from chatbots may be correct, it is still not fully meeting the needs of users as, in their words, "interactive to me is being able to change the information to work in the scenario that you're trying to give it" [P14]. As evidenced by this quote, there is potential for chatbots and other AIs to enhance their understanding of users' specific needs to ensure alignment between interaction styles and users' expectations for the particular contexts in which they are engaged.

In general, participants offered many suggestions on strategies for the information presentation to enhance chatbot interactivity. P8 summarizes this sentiment by stating, "the

idea of the artificial intelligence is to be interactive… more like a human. You can trust in the artificial intelligence when you feel like that intelligence seems like you." Therefore, the evidence from the interviews highlights the importance of aligning future AI interactions with users' expectations by formatting responses to their preferred modality (or multimodal) of information display and chatbot interaction style. This suggests a cognitive bias for the subjective perception of users' desire to process blood pressure and hypertension information from healthcare chatbots, known as a processing fluency bias (Alter & Oppenheimer, 2009). The individuations for how users expressed their processing fluency bias will be further elaborated in the final section of the qualitative results.

Enhancing User Experience Through Human-Like Chatbot Interactions

The participants in the conversational condition discussed this chatbot more positively as opposed to the participants who interacted with the informational chatbot. This led the participants to express aspects they appreciated that were unique to the experiences in the conversational experimental condition. One such design aspect was their perceived appreciation for the interaction freedom of the chatbot. With one participant stating they, "had the freedom to explore more than if it was just a normal 'learning module'... It was nice that you could keep probing and ask questions" [P4]. They specifically mentioned how they appreciated the conversational aspects of the chatbot as if there was something else "I need to know about high blood pressure... It was giving me options. I can talk more about this. And I can talk more about that. So it was beneficial." [P13]. Some participants even related this condition to human-like conversations, as one participant said, "it gave you like a simplified version that made sense on like a human

level… with this it's more like a human conversation… It was like reaching out to you, which I really liked" [P28]. Others mentioned how this chatbot "wasn't [using] language I didn't understand, it was almost like talking to a real person or a doctor" [P43] and how "it seemed friendlier… the sentence was constructed to feel more lifelike" [P22]. Moreover, if a participant was unsure about what questions to ask, the conversational chatbot would be "reminding you about things that you wouldn't [know]" [P26]. In addition to finding the conversational chatbot with human-like characteristics, participants found this chatbot to be more understandable than those who interacted with the informative chatbot. P5 remarked the language of the conversational chatbot is, "good because sometimes it uses informal and conversational communication… it's good to have, like broader audience… and [that it] gives options on what could be next."

Excessive Information Hindering User Engagement

While participants who interacted with the informative chatbot also expressed aspects of appreciating the language use and understandability of the chatbot, there was a stark contrast in the perceived learning difficulty for some participants when using the informative chatbot. A common theme among participants was that the responses of the chatbot were too long, with one participant saying "[it] gave me a lot of information, which is important, but also, it's a lot of things to read… so I was confused at the end" [P7]. Another participant remarked that even though the information was appropriate it was "just a lot of words. So maybe if there was a way to not necessarily condense that information, but just make [it] a little more easy to scan" [P15]. Adopting a similar perspective, P14 said, "[the language] wasn't overly complicated… it was very wordy… a lot of people, or

maybe just me, don't like to over read over explained stuff." They went on to suggest a chatbot's communication style could be "like a menu, where you give me the briefs of each information, and then I can decide where in depth I want to follow that chain" [P14]. These quotes illustrate a common scenario where, even though the information topic itself may have not been perceived as hard to understand, the chatbot's display of information was viewed as complex explanations. These types of exchanges led participants in the informative condition to express the need for chatbots that are more interactive to help users. P2 highlighted this concern, expressing "for a long text, it is so much, so it is hard to learn something about that. And I think interactive is the best option and quick option to get like faster answers." Another participant made an association between the chatbot's communication style and a textbook, but stating that when, "a person's explaining to you, they know how to break that information down in a more digestible way" [P14].

Processing Fluency Bias for Healthcare Chatbot Information Presentation

In the preceding sections, we presented the findings regarding the desire for various modalities of information display and the desire for personalized interactions with chatbots. Additionally, we described the general perceptions related to the conversational and informative conditions of information presentation. As participants suggested various methods to ease the cognitive processing of the information presented by healthcare chatbot, this final section will specifically analyze the differences in the individuations for this communication and present the overall evidence supporting the conceptualization for processing fluency bias in a reverse hierarchical graphic. As stated previously, the variation in participants' ideations for healthcare chatbot information presentation is evidence for a

cognitive bias known as processing fluency bias. This bias occurs when individuals have a subjective experience of ease in processing information (Alter & Oppenheimer, 2009).

Individuations for the Modality of Information Presentation and Interaction Style

Many of the participants said they would prefer visual learning in instances where they "don't understand something [about] the medical terms … a video [of] what happens to your heart and the left and right ventricles… [with] pictures that are labeled, it could generate a much more visual learning aspect" [P22]. There could even be variation in how such pictures and videos are generated. P38 discussed adapting content generations through a "fidelity scale, how realistic is it, if it [was] more animated", this could be beneficial in instances when "look[ing] up something with open surgery… could be very inappropriate… but when it is just a cartoon drawing… everything is [better]." Others suggested a preference for voice modalities saying it "is more interactive" [P8] and "a voice would be a very good customization… a person that works in the health system has to be very pedagogic" [P12]. However, not all people agreed a voice option would be beneficial for them, with one participant saying "I tend to ignore that. But [visuals] would be helpful for me" [P28]. This participant also remarked that if "[the chatbot] was aided more towards your learning style, I think that might be helpful for people to actually remember what they are learning" [P28]. Across the interviews, distinctions were identified for how participants desire chatbots to present information, and some participants made the connection of their cognitive processing preferences for how they use existing technology. Discussing this, P26 remarked, "I don't know if my preference for how I take in information is truly my preference, or if it's just been how I've been conditioned by using Google… Internet

browsers like Chrome or Firefox influence how I take in information." In reference to why they want to learn from visual aids, another participant said, "I would want to see that just because a lot of us are on Instagram all the time, watching videos and stuff" [P16].

Variations for the Subjective Experience of the Chatbot's Communication Style

Even though previous sections presented the general findings regarding participants' experiences with the conversational and informative communication styles, there were still discrepancies in these subjective perceptions. A few participants in the conversational condition expressed a preference for a more informative chatbot, stating "I prefer reading everything…generally, when I ask something, I want to have the complete information and not choose from different subjects… I'm not an expert at this, I want to read all the information" [P30]. As stated in the previous section, many participants in the informative condition expressed dissatisfaction in the length of the chatbot's responses, leading many to desire the information to be presented more "in a simple way" [P29]. P27 expressed their desire to "break [the information] down to the basics. Then through conversation, we can get into the more complex stuff." Contrary to this, some participants in the informative condition appreciated this interaction style, indicating preference for a "very thought out and informative" [P25] response. Furthermore, while P14 negatively compared the informative chatbot's communicating style to a textbook, P20 made the same comparison but from a positive perspective. They said "it's easier for me to synthesize information… it's very objective, like in a textbook. It doesn't need to be like a person. That's not a factor for me."

Aligning Interactions with AI to Users' Multifaceted Cognitive Abilities and Preferences

Overall, the study found many factors influencing preferences for information presentation, indicating a processing fluency bias among participants in the study. Most notably, participants referred to their learning preferences as a prominent factor influencing their desired method of information presentation. It has been theorized that different people possess different types of intelligences (e.g., visual, kinesthetic, logical, intrapersonal) (Gardner, 1983). So, depending on the multifaceted cognitive abilities of users and their general preferences for how they desire to process information, this may affect their processing fluency bias. Referring back to P8's quote, "the idea of the artificial intelligence is to be interactive… more like a human. You can trust in the artificial intelligence when you feel like that intelligence seems like you." These findings reveal there may be deeper complexities for the constitution of interactive and intelligent AI, where this engagement is reflective of the unique mechanisms of how individuals think and learn. Therefore, a key aspect of intelligence for AI may embody the alignment of its interaction and responses to resemble the diverse cognitive mechanisms of its users. This alignment may vary based on users' subjective perceptions of ease in processing information, indicating a processing fluency bias. The results of the inductive thematic analysis presents this conceptualization hierarchically in Figure 4.1.

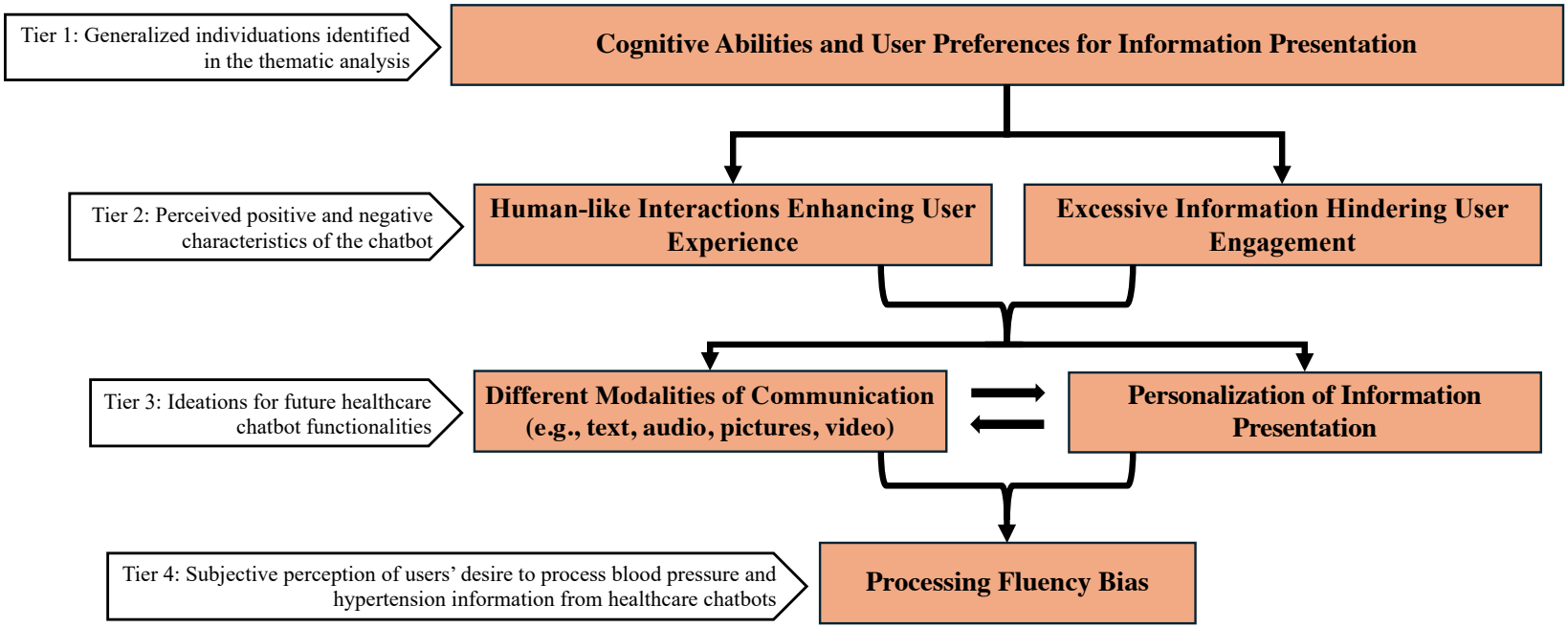


Figure 4.1: Conceptualizing an Individual's Processing Fluency Bias from the Generalized Themes Identified in the Inductive Thematic Analysis

In Figure 4.1, Tier 1 represents the generalized individuations influencing user preferences for information presentation. These preferences impacted the interaction users generally had with the healthcare chatbot implemented in the study, as shown in Tier 2. This tier demonstrates how, generally, the human-like characteristics of the conversational chatbot led to increased positive perceptions and the information dense informative chatbot had increased negative experiences. Tier 3 illustrates users' desires for engagement in multimodal contexts and the personalization of information presentation to meet the needs of specific contexts. The findings of Tier 2 inform the emergence of Tier 3. For example, if users found the text-based information excessive, they ideated for different modalities (e.g., video with audio cues) to align the information presentation with their preferred cognitive mechanisms. Another example involves the users who appreciated (or desired) the conversational interactions of the healthcare chatbot. They envisioned and desired future chatbots to enhance this communication style by incorporating characteristics such as increased empathy when discussing health topics in specific contexts. The double arrows depict the reciprocity within Tier 3, reflecting, for example, participants' preferences for empathetic (or not empathetic) communication and tailoring the fidelity level of pictures or videos generated to meet the needs of specific contexts. Finally, the aggregation of these tiers leads to the conceptualization of a processing fluency bias for healthcare chatbot information presentation, as shown in Tier 4. This tier is the culmination of the varying factors impacting the processing fluency bias for healthcare chatbots disseminating blood pressure and hypertension information in this study.

This figure represent these factors in a generalized form, indicating the general preference (or desire for participants in the informative condition) for the human-like characteristics of the conversational chatbot over the information-dense informative chatbot. It also illustrates the broad desire for multimodal interactions and personalized information presentations tailored to specific contexts. However, it is important to acknowledge that not all users shared these generalized preferences for empathetic or human-like chatbot interactions. Some users favored (or desired for participants in the conversational condition) the detailed information presentations, appreciating structured and comprehensive responses. The variations in preferences and expressed individuations exemplify processing fluency bias because they reflect subjective perceptions that ease an individual's cognitive processing of the information presented by the healthcare chatbot. This highlights the importance for the alignment of users' multifaceted cognitive abilities and information presentation preferences with the generative capabilities of chatbots and other forms of AI.

CHAPTER FIVE:
DISCUSSION

The objective of this study was to investigate the effect of varying healthcare chatbot information presentation styles on user experience. The information presentation of the chatbot was manipulated by two independent variables: communication style (conversational or informative) and language style (technical or non-technical). A mixed-methods approach was employed, utilizing Bayesian statistics to quantitatively evaluate varying information presentations on the effectiveness, trust, and usability of a healthcare chatbot. The qualitative analysis conducted inductive thematic analysis from semi-structured interviews, providing insight on participants' perspectives and experiences regarding the different chatbot conditions. The results demonstrate the nuanced factors for the design of a healthcare chatbot, emphasizing the impact of communication and language style, as well as the impact of interactions between explanatory variables on the outcome measures. Furthermore, the inductive thematic analysis's identification of a processing fluency bias for healthcare chatbot information presentation has important implications for the designs of chatbots and other AI systems.

Effectiveness

For the effectiveness of the healthcare chatbot, this was shown to significantly decrease if users perceived the chatbot as less usable. This finding was supported by the qualitative analysis, which revealed diverse perspectives regarding the chatbot's usability and how it impacted their ability to engage with the chatbot. Many past studies have investigated the importance of chatbot usability for healthcare specific chatbots,

demonstrating its importance on their effectiveness (Abd-Alrazaq et al., 2020; Bickmore et al., 2010; Biro et al., 2023; Chagas et al., 2023; Larbi et al., 2022). However, as noted by Tudor Car et al. (2020), the factors affecting a chatbot's effectiveness is still limited at the current state of the literature. Given this, it may be valuable to draw from established theories to gain insight on why participants reported varying difficulties in processing the information and to explain the effect of a chatbot's perceived usability on its effectiveness for users in an information seeking task. One such theory, cognitive load theory (CLT), first posited by Sweller (1988), proposes that an individual's working memory has limited capacity to process information within a given sequence, and for this, instructional methods should aim to prevent excessive cognitive load to enhance learning outcomes. While the information that must be processed by users varies across many dimensions, a critical feature of the information exchange is the extent to which relevant elements interact (Paas et al., 2003). Information exists along a spectrum ranging from low to high element interactivity. Element interactivity focuses on the complexity of information in relation to an individual's prior knowledge and drives the intrinsic cognitive load of an individual (Paas et al., 2003). If element interactivity is low, new items can be understood without reference to other items, but if element interactivity is high, new material cannot be understood until all elements are processed simultaneously (Paas et al., 2003). This interaction of processing information has consequences for how the human cognitive system functions as it affects both working memory and long-term memory. Another critical factor of cognitive load is how the information is presented – termed the extraneous cognitive load (Sweller, 2010). This becomes particularly crucial when the intrinsic

cognitive load is increased, as the combined effects of the two forms of cognitive load are additive (Sweller, 2010). So, presenting complex information designed to reduce cognitive load is particularly effective when element interactivity is high (Paas et al., 2003). In such scenarios, this approach is applicable when the information requires high working memory load, is hard to understand, involves elements that need to be learned simultaneously, and when elements of the information interact with each other (Paas et al., 2003). Considering there are many factors leading to individual differences in cognitive load (Bevilacqua, 2017; Castro-Alonso et al., 2019; Sweller, 2024), future work should investigate understanding information presentation in the context of healthcare chatbots for the reduction of cognitive load. By leveraging the potential of generative AI to present information with varying degrees of intrinsic and extraneous complexity, chatbots could enhance their usability and overall effectiveness for this technology. This is supported by the qualitative analysis, which found that aligning users' cognitive abilities and preferences for information presentation with the generative capabilities of chatbots and other forms of AI could result in diverse and effective displays of complex information, adapting to a wide range of users.

The qualitative analysis in my study also revealed that while participants reported their appreciation for the characteristics of either the conversational or informative chatbot, there was a greater frequency of users encountering difficulty with processing the chatbot's responses in the informative condition. This was reflected in the posterior probability distributions from the Bayesian model because even as there was found to be no main effect on the communication style, differences in the chatbot's effectiveness were found to be

significantly affected by the interaction of the communication style and its perceived usability for participants. Users exposed to the informative condition with lower perceived usability did significantly worse than those who reported the informative chatbot with higher usability. This finding aligns with the inductive thematic analysis, which provided evidence of a processing fluency bias (i.e., individuals' subjective perception of how easily they process information) (Alter & Oppenheimer, 2009) when engaging in information-seeking tasks with a healthcare chatbot. The significant differences in effectiveness scores, based on the interaction effect of user perceptions of usability and chatbot communication style, further support the existence of a processing fluency bias for healthcare chatbot information presentation.

In the interviews, participants ideated many examples (e.g., videos, pictures, audio) of how future chatbots and conversational agents can ease their cognitive load and increase their processing fluency. Processing fluency bias further manifested itself within both the conversational and informative conditions, as participants expressed their appreciation and likeness for their assigned communication style, while others articulated a desire for interacting with a chatbot embodying the contrasting condition. Moreover, it is significant to highlight that participants who perceived the conversational chatbot with lower usability did significantly better than participants with the same perception in the informative condition. As the conversational condition was characterized by its ability to parse out information and provide users with greater interaction freedom, this finding may imply that users with a lower processing fluency of blood pressure and hypertension may benefit from a communication style that is conversational rather than informative. This aligns with

cognitive load theory as the reduction of extraneous cognitive load improves the ability for the processing of information with high intrinsic complexity. Therefore, a conversational chatbot may be more affective at alleviating the cognitive load and increasing the processing fluency a user experiences when learning health information. This finding can help guide future research to investigate differences in cognitive load experienced by users learning health-related information from chatbots with varying communication styles. The further investigation of how healthcare chatbots present information to users may lead to reduced cognitive load and improve users' processing fluency when engaging in health-related topics.

Trust

Another important consideration for how health information is presented is its effect on a user's trust in the chatbot. The posterior distributions from the Bayesian model revealed that perceiving the chatbot with higher usability significantly decreased the likelihood of being less trusting of the chatbot. This aligns with previous studies showing a positive relationship between trust and usability in technological systems (Acemyan & Kortum, 2012). Other research investigating components of usability such as performance and capability also observe similar trends, leading researchers to describe this linear relationship as *calibrated trust* and suggests that a system's capability and a user's trust should be linearly related (Asan et al., 2020; R. R. Hoffman et al., 2013). Similarly, the use of non-technical language decreased the likelihood of finding the chatbot less trustworthy. In the available literature, it is believed this is the first, or one of the first, studies to indicate non-technical language leads to increased trust in text-based healthcare chatbots. While

studies have investigated the role of language by looking into factors such as formal and informal language in health-based and non-health based chatbots (Araujo, 2018; Chaves et al., 2022; Gretry et al., 2017; Ollier et al., 2021), fewer have specifically investigated the use of technical or non-technical language in health-based or non-health-based contexts, such as this study or the work by Biro et al., (2023).

Other text-based design characteristics that have been shown to increase user trust have been communication styles employing socioemotional dialogue and conversational styles that normative or culturally familiarly (Rheu et al., 2021). However, the posterior distributions from the Bayesian model revealed the conversational condition significantly increased the likelihood of being less trusting of the chatbot, contradicting our hypothesis outlined in the methods. This is especially interesting given the qualitative interviews reported the conversational chatbot to have greater interaction freedom, ease of learning, and perceived human-like characteristics. In contrast to past research, increased human-like characteristics and usability of technology has been shown to increase users' trust (Acemyan & Kortum, 2012; Fu et al., 2023; Kraus et al., 2016; Lohani et al., 2016; Nordheim et al., 2019; van den Brule et al., 2014). Another unexpected finding was the interaction between non-technical language and perceiving the chatbot as more usable significantly increased the likelihood of the chatbot being less trustworthy. This finding is surprising as it, too, counters the conventional presumption that users would trust AI that communicates with high usability (Acemyan & Kortum, 2012; Asan et al., 2020; R. R. Hoffman et al., 2013), irrespective of an interaction effect. One study found similar unexpected results when they demonstrated that ChatGPT's greater task efficiency resulted

in an increase of a user's perceived creepiness (i.e., the uncanny valley effect) (Baek & Kim, 2023). The uncanny valley effect hypothesizes that users feel uncomfortable when robots (e.g. AI) appear and behave too closely too humans. This effect has been studied for decades, with most of the research in the context of physical resemblance of robots to humans (Baek & Kim, 2023; Ho & MacDorman, 2010; Hyun Baek & Kim, 2023; Laakasuo et al., 2021; Mori, 1970; Seymour et al., 2021), but there is no consensus for what causes this effect. One possible cause for the uncanny valley effect is when users interact with technology (e.g., generative AI) that outperforms their expectations (Shank et al., 2019). Our study did not directly measure the uncanny alley effect, and thus, we cannot directly link this to the decreased trust associated with the main effect of the conversational condition and the interaction effect between non-technical language and perceiving the chatbot with higher usability. Albeit the uncanny valley effect is known to negatively impact trust as demonstrated by Song (2023). Moreover, recent studies have recognized its relevance in generative AI (Hyun Baek & Kim, 2023; Seymour et al., 2021), providing cause for future research to further investigate the complex factors of information presentation impacting trust in chatbots and conversational agents for healthcare and other contexts.

In the field of human-AI interaction, there exists a lack of consensus on the factors influencing trust (Benk et al., 2022; A. D. Kaplan et al., 2023; Lukyanenko et al., 2022; Sheridan, 2019), catalyzing new frameworks for the understanding of trust in AI (e.g., AI as socio-technical systems, Foundational Trust Framework, calibrated trust). As this study demonstrates a complex relationship between information presentation and trust, future

developments of trust frameworks should consider design characteristics such as communication and language styles in their models.

Usability

The posterior distributions from the Bayesian model for trust revealed the complex effect of usability on user trust. Correspondingly, when trust serves as an explanatory variable for the outcome measure of perceived higher usability, it also exhibits intriguing outcomes. The usability Bayesian model found that when users have lower trust in the healthcare chatbot, the likelihood of perceiving the chatbot with higher usability decreases. On the contrary, the interaction effect between the utilization of non-technical language and having lower trust in the healthcare chatbot resulted in perceiving the chatbot with higher usability. As described in the previous section, it is expected to find the direct relationship between user trust and usability (Acemyan & Kortum, 2012). However, the interaction effect of perceiving the healthcare chatbot with lower trust and non-technical language is another interesting finding which may indicate a deeper complexity in the relationship between trust and usability in human-AI interaction. While there have not been any studies discovering this specific interaction effect, drawing from other research areas in the field of HCI and human-AI interaction may help provide context for this finding.

The field of explainable AI (XAI) focuses on the understanding and interpretation of AI systems (Linardatos et al., 2020). One of the aims of XAI aims is to enhance the usability, and thereby, foster trust in AI technology (Alufaisan et al., 2021; Lai et al., 2020; Ribeiro et al., 2018). It does this is by understanding how information should be communicated and what should be presented, making information presentation a critical

design choice in XAI (Ridley, 2024). This importance is underscored by the emergence of a subfield of research within HCI known as human-centered explainable AI (HCXAI), dedicated to designing and applying techniques and principles that align with the explanatory needs of users (Ridley, 2024). However this field has shown inconsistent results as demonstrated by findings showing explanations led to over-trusting models (Bansal et al., 2020; Kaur et al., 2020; Lakkaraju & Bastani, 2020; Poursabzi-Sangdeh et al., 2018) or inappropriately distrusting the AI (Yang et al., 2020). There have even been findings with similar mixed results, where enhanced usability through XAI leads to increased understanding but not trust (Chiou & Lee, 2023; Ehsan et al., 2021; Kastner et al., 2021). In healthcare chatbots, there is not enough existing literature to deterministically conclude the use of non-technical interaction with a perception of lower trust in chatbots is a significant factor increasing usability. However, my study does demonstrate some evidence of its importance. Investigating information presentation designs is a novel research direction in the field of human-AI interaction, and the presented findings can help guide future research in different fields of AI. For example, in the field of XAI, future investigations could explore the impact of factors such as language styles on usability and trust to meet the explanatory needs of its users.

Another finding from the posterior distribution in the Bayesian model is the increased perceived usability for participants who engaged with the conversational chatbot. The qualitative analysis also reflects the posterior probabilities as users generally reported more positive perceptions regarding this condition. These finding present mixed results when compared to the existing literature. While one study found a chatbot with a human-

like communication style did not significantly improve the perceived usefulness and ease of use (de Sá Siqueira et al., 2023), others have reported these characteristics increase utilitarian value and satisfaction (Jo & Park, 2024). It is important to state the literature referenced is not within the domain of healthcare chatbots, so it may not be applicable to generalize findings across different contexts for usability and other outcome measures. As such, future research within health-related chatbots and conversational agents should seek to confirm or challenge these findings.

Processing Fluency Bias

The qualitative interviews, also, revealed a significant insight regarding the enhancement of usability as they expressed desires for various modalities of information presentation to ease their processing fluency of health information. Previous research in health psychology has examined the impact of processing fluency on written health information, demonstrating its importance not only in making health information more comprehensible but also in enhancing self-efficacy to adopt health behaviors (Okuhara et al., 2020). In the field of human-AI interaction, other studies have also revealed the importance of improving users' processing fluency when engaging in this technology (Lan et al., 2024). This study contributes to the literature by providing evidence supporting multimodal communication for healthcare-based chatbots and conversational agents. Finding that the incorporation of photos, videos, or verbal communication may enhance user experience and reduce cognitive load. Learning from conversational AI capable of providing both visual and auditory information can induce a cognitive load learning effect known as the modality effect. This effect occurs when a mixed-mode presentation –

featuring both visual and auditory elements – is more effective than presenting the same information in a single mode, either visual or auditory alone (Low, 2012). However, under certain learning conditions, a reverse modality effect may occur, wherein learning with text accompanied by graphical representations can result in increased learning performance than oral narration accompanied by graphical representations (Leahy & Sweller, 2011, 2016). The increased modalities of information presentation for AI may be able to enhance learning outcomes in certain learning conditions, but it is important to draw from other theories in the cognitive load theory literature finding that redundant information can lead to decreased learning outcomes (i.e., the redundancy effect). The redundancy effect occurs when learners exposed to redundant information learn less compared to those who receive the same information with redundant information excluded (Sweller, 2024). Therefore, conversational agents utilizing various modalities of information presentation may contribute to enhanced healthcare education experiences for users. However, the redundancy effect may emerge when users are presented with redundant information that does not contribute to learning, posing design challenges for user experience and interfaces in AI systems.

Generative AI has the potential AI to improve processing fluency by adapting information presentation to users' cognitive mechanisms and preferences, which introduces further design considerations for AI system designers beyond the general user experience and display design. Future designers seeking to improve processing fluency in AI systems must also be aware of studies showing that fluently processed material tends to appear more familiar (Kelley & Rhodes, 2002; Schwarz, 2004), is more likely to be

accepted as true (McGlone & Tofighbakhsh, 2000; Reber & Schwarz, 1999), and is less likely to be critically examined (Claypool et al., 2004; Garcia-Marques & Mackie, 2001). This has significant implications when designing for healthcare education because designing information presentation to be processed too comfortably may have adverse complications. Future research should explore how generative AI's capabilities can be used to facilitate information processing without compromising critical thinking, thereby preventing users from accepting repeated information as true when a chatbot's response may not be accurate (i.e., the illusory truth effect) (Hassan & Barber, 2021). This is especially critical given the ability for LLMs generate nonsensical and misleading responses, termed "artificial hallucination" (Alkaissi & McFarlane, 2023; Ji et al., 2023).

As evidenced in this study, the presentation of information reveals significant effects on a healthcare chatbot's overall user experience. The modality of communication in this study was text-based, but there are already consumer available LLMs capable of producing text, photos, speech, and videos ("ChatGPT Can Now See, Hear, and Speak," 2023; "Creating Video from Text," 2024; "Hello GPT-4o," 2024). Even more, education companies such as Khan Academy are aiming to utilize this recent advancement in technology for enhanced learning outcomes (Khan, 2023). Yet, as underscored in this study, there may be important design implications for the presentation of education material, such as health information. Therefore, future research should further investigate communication and language style in text-based and across other modalities, within the context of information presentation. This exploration could improve users' processing fluency of health information, alleviating cognitive load and potentially cultivate improved

learning conditions, such as the modality effect and reverse modality effect. Additionally, it could provide insights into aspects of user experience that lead to instances where comfortably processed information is not critically examined or mistakenly accepted as true.

Limitations and Future Research

The study's limitations include the short interaction time participants had with the chatbot, potentially not capturing its long-term effectiveness or user experience. Future research could conduct longitudinal studies with chatbots utilizing various information presentations to assess sustained impact and user engagement. It could also investigate whether the introduction of healthcare chatbots leads to differences in how individuals interact and engage with their care providers. Given that all participants were either current university students or graduates, the generalizability of the results to individuals with differences in educational backgrounds may be limited. Future work should evaluate different types of populations and age groups to gain insight on how information presentation affects the outcome measures utilized in this study. Moreover, instructing participants to learn blood pressure and hypertension information to assist the hypothetical friend 'Linda Walker' may not accurately reflect real-world health information seeking task. However, this scenario was intentional to mitigate ethical concerns regarding the learning of health information. We aimed to prevent participants from acquiring personal health information, as this was a healthcare chatbot and not a real doctor. Therefore, the task of learning health information for someone else, in this case, 'Linda Walker', was implemented to minimize ethical issues. Regarding the choice of the chatbot's name used

in the study, MedMind ChatGPT, it could be considered another limitation. This is because participants may have interacted with the chatbot differently due to the inclusion of the term "ChatGPT." As most of the participants had previous interactions with OpenAI's ChatGPT, external perceptions associated with this term may have influenced their interaction styles and engagement with the healthcare chatbot. Another potential limitation of this study was the sample include size (n=11) per condition, provoking cause for similar studies with larger sample sizes. The sample size, however, was determined to be sufficient from the BFDA. Nonetheless, future work should include more diverse populations which may require larger sample sizes and representations. Furthermore, the study's controlled environment was another limitation, as the chatbot displayed answers uniformly to all participants. This design was intentional to ensure all participants had an equal opportunity to be exposed to the exact same health information, with differences in its presentation varying across each of the four controlled conditions. Yet, this design may lack the robustness often observed in real-world interactions with contemporary conversational agents. Nonetheless, the study's findings support the need for future research to investigate design and implementation strategies for chatbots within specific contexts. With previous research in information system technology showing a general lack of emphasis on the context of use, questions have arisen about the applicability of the results in this field to real-life settings (Nielsen & Sahay, 2022; Venkatesh et al., 2011). Recent work by Hsu et al. (2023) attempt to bridge this gap, focusing on information presentation styles in the realm of e-commerce, demonstrating a clear effect for the level of intrinsic and extrinsic task complexity for chatbots on user experience. Yet, the understanding of this effect is

limited to business contexts (Hsu et al., 2023). Similarly, as my study demonstrates evidence for the effect of information presentation on effectiveness, trust, and usability, the generalizability of these findings may be limited to healthcare chatbots disseminating blood pressure and hypertension information. Future work should seek to validate these findings within the context of healthcare based chatbots and conversational agents. Notably, subsequent investigations can build off the findings of my study using Bayesian methods. As another limitation in my work is the utilization of non-informative priors, this may not accurately reflect the true probability distributions of the explanatory variables in the models. However, if more researchers in the fields of human factors, HCI, and beyond adopt Bayesian methods and publish their findings, a growing body of knowledge can accrue. These updated beliefs would be capable of being applied across diverse user experiences, informing the interaction between humans and AI (e.g., tailored information presentation to individual users) and provide inference for how such interactions may affect a range of outcome variables.

Conclusion

Overall, this thesis presents evidence for the effect of varying information presentations within healthcare chatbots on user experience. By utilizing a mixed-methods approach, we were able to provide context for the findings seen in the posterior distribution from the Bayesian models. For example, the qualitative interviews reported mixed perceptions on the usability of the different chatbot communication styles. This may explain the interaction effect in the posterior distribution for the effectiveness model between the chatbot's communication style and a participant's perception of whether the

chatbot had low usability or did not have low usability. My thesis study also demonstrated results contrary to our original hypotheses. The qualitative interviews reported the conversational style of the healthcare chatbot was perceived with a greater ease of learning and, for some participants, more human-like. Yet, the posterior distribution in the trust model found the conversational condition to increase the likelihood of being less trusting of the healthcare chatbot, while increasing the likelihood of perceiving it as more usable in the posterior distribution of the usability model. Moreover, the findings demonstrate an intricate relationship between trust and usability. Both demonstrating direct main effects that are positively correlated in their respective models, however, they also exhibit a negative correlation relationship in their interaction effect with the language style of the chatbot. These findings may indicate various information presentation styles may have complex effects on perceived trust and usability and can provide insight to inform future research directions for healthcare chatbots and other research domains of human-AI interaction. The inductive thematic analysis also revealed an important finding regarding how users engage with healthcare chatbots, finding a processing fluency bias related to the use of varying information presentations. The unique findings in this study highlight nuanced user preferences for the presentation of health information for CAs and reveal evidence for diverse cognitive preferences for health information display. Future designers of health educational materials in AI systems should give careful consideration to the cognitive abilities of their users, ensuring the robust capabilities of AI enhance their learning experience rather than inundate them with redundant or unnecessary information that hinders learning. This is evidenced by my study, which highlights the challenges

associated with a healthcare chatbot's information presentation and underscores the importance for healthcare chatbots to present information that is easily understood and communicate with contextual considerations. It is crucial for researchers in human-AI interaction to ensure increased processing fluency still promotes critical thinking and does not compromise user's ability to identify when information provided by generative AI may be incorrect. Furthermore, the lack of comprehensive understanding for the diverse contextual factors across distinct domains (e.g., health, e-commerce, routine management, skill training, customer service) suggests we may not be able to leverage the literature from general chatbots for specific chatbot purposes. In order to bridge this gap for various communicative settings, improved user and context models need to be developed for the wide-range needs of specific users (Brandtzaeg, 2018). This perspective advocates for the analysis and redesign of the interaction between human and conversational agents – not just for specific interaction sequences, but with the intention to enhance generative responses across a diverse user range within various conversational contexts (Brandtzaeg, 2018). For this reason, it is imperative for the designers of future systems of conversational agents to gain insight on users desires, needs, and way they use chatbots (Brandtzaeg, 2018). My thesis presents a novel Bayesian approach to address human-AI interaction and can serve as a framework to design future studies exploring this field. The premier human factors journal, *Human Factors*, only has three published papers utilizing Bayesian methods (Alambeigi & McDonald, 2023; DinparastDjadid et al., 2021; Neyens et al., 2015), indicating numerous opportunities for this field to pose untested hypotheses and acquire new knowledge. By facilitating knowledge in the form of prior beliefs into

Bayesian statistical models, future research can expand upon these findings to gain insight on the information presentation needs of users in numerous healthcare contexts. Furthermore, this methodology is relatively efficient in design, making it poised to address the challenges related to information presentation in healthcare contexts and beyond.

Inadequate health literacy disproportionately affects lower socioeconomic and minority groups and is estimated to cost the U.S. healthcare system up to an additional $238 billion (Vernon et al., 2007). This is a critical issue affecting many populations, so efforts to provide accessible healthcare education have the potential to greatly impact healthcare systems, both in the U.S. and globally (Hahn & Truman, 2015; Rizvi, 2022). Given the complex and technical nature of health-related information ("Understanding Health Literacy," 2023), it is imperative for the field of human-AI interaction to design the engagement with AI and its information presentation to algin with users' expectations and preferences. This alignment is not only crucial for enhancing the understanding of healthcare information but also for broader applications. For AI to create genuine transformation in society requires the effective dissemination of information available through the human-AI interface that meets the unique abilities and preferences for its user.

APPENDICIES

Appendix A: Pre-test on Blood Pressure and Hypertension

Choose the best option below. Participant #_____

1. Blood pressure has two parts, the systolic and diastolic pressure. What does the systolic blood pressure represent?
    a. It represents the pressure in the arteries when the heart rests between beats.
    b. It is a representation of the total volume of blood in your circulatory system.
    c. It represents the pressure of blood through your arteries when the heart is contracting.
    d. It is the number of times the left and right atria contracts within a minute.
2. Which of these blood pressure readings is the most ideal?
    a. Around 80/110
    b. Between 40/80
    c. Higher than 130/90
    d. Lower than 120/80
3. Which factor below is the number one cause of high blood pressure?
    a. Aging
    b. Stress
    c. Unknown
    d. Obesity
4. If you are suffering from high blood pressure, you may have:
    a. Back pain
    b. Higher risk of heart attack and stroke
    c. Numb, tingling feeling in left arm
    d. Diarrhea
5. Medication for high blood pressure is usually taken:
    a. On a lifelong basis
    b. Only under stressful situations
    c. When doing physically demanding activities
    d. When a person has decreased energy levels
6. Which of these is more likely to increase your blood pressure long term?
    a. Physical activity
    b. High cholesterol level
    c. Ice cream
    d. Salt or sodium intake
7. Which of these can be harmful to people who are suffering from high blood pressure?
    a. Over the counter cold and flu medicines
    b. Bacon
    c. Physical activity
    d. Low white blood cell count
    e. None of the above

8. Blood pressure has two parts, the systolic and diastolic pressure. What does the diastolic blood pressure indicate?
    a. It represents the pressure in the arteries when the heart rests between beats.
    b. It is a representation of the total volume of blood in your circulatory system.
    c. It represents the pressure of blood through your arteries when the heart is contracting.
    d. It is the number of times the left and right atria contracts within a minute.
9. What is the top number of the blood pressure reading?
    a. Systolic
    b. Diastolic
    c. Tricyclic
    d. Probiotic
10. What is the bottom number of the blood pressure reading?
    a. Systolic
    b. Probiotic
    c. Diastolic
    d. Tricyclic
11. What is another term for high blood pressure?
    a. Laziness
    b. Hypertension
    c. Hyperlipidemia
    d. Hypotension
12. What is the most common risk associated with low blood pressure?
    a. Dizziness or fainting
    b. Hair loss
    c. Flushed face
    d. Skin rash
13. For a young, healthy individual, what is the best way to prevent high blood pressure?
    a. Nothing because it's genetic
    b. Exercise regularly
    c. Intake more sodium
    d. It is only possible with medication
14. What percentage of women aged 35-44 will have high blood pressure?
    a. 20%
    b. 33%
    c. 40%
    d. 25%
15. What ethnic group is most at risk for developing high blood pressure?
    a. Hispanic
    b. Asian and Pacific Islanders
    c. African American
    d. Caucasian
16. Over a lifetime, what is the risk of developing high blood pressure?
    a. 20%

b. 90%
c. 50%
d. 75%

17. Which of these is NOT a common symptom of high blood pressure?
    a. Headaches
    b. Sweating
    c. Blurred vision
    d. Chest pain
18. Which of these blood pressure readings is considered prehypertension?
    a. 120/80
    b. 130/85
    c. 140/90
    d. 150/95
19. Which of these is a potential complication of untreated high blood pressure?
    a. Kidney failure
    b. Type 1 diabetes
    c. Gallstones
    d. Osteoporosis
20. Research has shown which of the following substances can help control blood pressure levels?
    a. Tylenol
    b. Zinc
    c. Omega-3
    d. Vitamin D
21. Which of these substances is known to raise blood pressure in some people?
    a. High levels of potassium
    b. High levels of caffeine
    c. Low levels of magnesium
    d. Low levels of iron
22. Which of the following symptoms is most likely associated with hypertension?
    a. Headaches
    b. Sweating
    c. Blurred vision
    d. Chest pain
    e. None of the above, it is symptomless

Appendix B: Trust Survey (from Qualtrics)

Start of Block: Honesty

Q1 The chatbot provides truthful information.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q2 The information provided by the chatbot is believable.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q3 The content of the chatbot reflects competency.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q4 The chatbot content reflects expertise.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

End of Block: Honesty

Start of Block: Predictability

Q5 The chatbot content is what I expected.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q6 There were no surprises in how the chatbot responded to my actions.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q7 The chatbot content is predictable.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

End of Block: Predictability

Start of Block: Perceived ease of use

Q8 Learning to operate this chatbot was easy for me.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q9 I found it easy to get this chatbot to do what I wanted it to do.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q10 I found the chatbot easy to use.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

End of Block: Perceived ease of use

Start of Block: Risk

Q11 I am taking a chance interacting with this website.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q12 I feel I must be cautious when using this website.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q13 It is risky to interact with this chatbot.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

End of Block: Risk

Start of Block: Trust

Q14 I believe this chatbot is trustworthy.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

Q15 I trust this chatbot.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree

End of Block: Trust

Appendix C: Informative and Technical Chatbot Answers

Introduction
Hello, my name is MedMind GPT. I'm here to help you learn about blood pressure today. You can ask questions about understanding blood pressure, learning how to manage or prevent it, who is affected, and more. What is your first question?

Generic
I am sorry, I am unable to answer that question. I am only trained to answer questions related to blood pressure topics. Do you have questions regarding blood pressure?

I am sorry, I am unable to answer that question. Do you have another question about blood pressure?

I am sorry but it does not appear that I have an answer for that. I will look into that in the future. Do you have another question about blood pressure?

I am only a chatbot and I don't know quite know what you are asking. Can you please ask your question in a different way?

I am only a chatbot and I don't know how to answer your question. Can you please ask your question in a different way?

Where can I find more information about high blood pressure?
The American Heart Association has more information on blood pressure if you wish to explore more later. I cannot currently send you there.

Risk
Why should I care?
(https://www.webmd.com/hypertension-high-blood-pressure/5-misconceptions-about-hypertension; https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Wade, C. (1975))

Hypertension is the largest single causative factor in all deaths. Hypertension (high blood pressure) causes the arterioles to tighten, resulting in the heart having to work harder to pump blood through the tissues to extremities and vital organs at a normal rate. Hypertension is a dangerous ailment because of its effect on the walls of arteries. Hypertension accelerates the ailment of atherosclerosis which causes the arteries to harden and reduces the elasticity of the affected arteries. Over time, this hardening can have detrimental effects including increased risk of brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure.

What are the risk factors?

(https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Wade, C. (1975))

Hypertension (high blood pressure) is a dangerous ailment because of its effect on the walls of arteries. It accelerates the ailment of atherosclerosis which causes the arteries to harden and reduces the elasticity of the affected arteries. Over time, this hardening can have detrimental effects including, but not limited to, increased risk of brain hemorrhage, myocardial infarction, coronary artery disease (3x more likely), and kidney complications. Coronary artery disease and brain hemorrhage are the first and fifth leading cause of death in the United States.

What are comorbidities with high blood pressure?
(Kaplan, N. M., & Lieberman, E. (1979))

Some possible factors that may be observed simultaneously or in conjunction with high blood pressure include high cholesterol, obesity, or diabetes. Increased incidences of the following diseases have been found when hypertension (high blood pressure) is presence: uterine fibromyomas, gout, quadriplegia, menopause, and polycythemia (slow growing blood cancer). Research is still needed to learn about these diseases and their connection to high blood pressure.

Symptoms

What are symptoms? What are symptoms of high blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Hypertension (high blood pressure) is particularly dangerous as it is generally symptomless. Individuals can have it for years without knowing. One in three Americans with the condition are not consciously aware of having developed it and this absence of symptoms gives it its name: the "silent" killer. Many of the possible symptoms of hypertension (e.g., headaches, vertigo, light-headedness, nosebleeds) are just as commonly in people with normal blood pressure. Symptoms simply cannot be relied upon as early warning signs of hypertension.

How can you tell if you have high blood pressure? How do I know if I have high blood pressure?
(Wade, C. (1975))

The best way to determine if an individual has hypertension (high blood pressure) is through regular checkups. Many of the symptoms of hypertension (e.g., headaches, vertigo, light-headedness, nosebleeds) are just as commonly in people with normal blood pressure. Symptoms simply cannot be relied upon as early warning signs of hypertension.

Causes

What affects blood pressure? What causes high blood pressure?
(https://www.webmd.com/hypertension-high-blood-pressure/guide/blood-pressure-causes#1, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

The specific cause of hypertension is unknown, but several factors may play a role including age, race, family history, weight, tobacco consumption, being physically inactive, stress, sodium, alcohol, and certain chronic conditions.

- Age: The risk of high blood pressure increases as an individual ages with an approximately 90% chance of developing high blood pressure in a lifetime. The stress an individual incurs in life results in higher blood pressure levels along with the loss in elasticity of the arteries due to an increased age.
- Race: Hypertension (high blood pressure) is particularly common among people of African heritage, often developing at an earlier age than it does in Caucasians. Serious complications, such as brain hemorrhage, myocardial infraction, and kidney failure, are also more common in people of African heritage potentially due to this increase prevalence of hypertension although the exact reason for the racial disparity remains unclear.
- Family history: Hypertension (high blood pressure) can be genetic; it tends to run in families particularly as a comorbidity of other hereditary diseases that may have hypertension as a complication such as diabetes.
- Being overweight or obese: The more an individual weighs the more blood carrying oxygen and nutrients to their tissues they need to supply via the arteries. As the volume of blood circulated through the arteries increases, so does the pressure on the artery walls resulting in damage to the arteries. The heart also has to work harder to pump more blood through a larger body causing an increased risk for hypertension (high blood pressure) as well as coronary heart disease and myocardial infraction.

Continue generating? (Y/N)

- Not being physically active: People who are inactive tend to have higher heart rates, creating strain on the heart to contract and relax more frequently. The higher a heart rate is, the harder the heart must work with each contraction resulting in a stronger force on the arteries; this strong force causes the slow deterioration of the arteries walls and their elasticity. Lack of physical activity also increases the risk of being overweight if not managed with a proper diet. It is also important to understand that blood pressure may increase temporarily initially after exercising but in the long-term, being active can help lower blood pressure levels as well as potentially help lose weight which is also

important for managing blood pressure. Before starting any workout regime though, you should consult your doctor to ensure that it is safe to do so.

- Using tobacco: Not only does smoking or chewing tobacco immediately raise blood pressure temporarily, but the chemicals in tobacco can damage the lining of the arterial walls. This can cause arteries to narrow and increases the risk of coronary artery disease; secondhand smoke also can increase the risk of coronary artery disease. Coronary artery disease is the leading cause of death in the US.
- Too much sodium (salt) in your diet: Too much sodium consumption narrows the passageways of small arteries by causing arterioles to swell and therefore results in exerting more force on the arterial walls. Too much sodium in a diet also causes the body to retain fluid which results in more volume of blood and further raises blood pressure which in turn strains the heart.
- Too little potassium in your diet: Potassium helps balance the amount of sodium in your cells (sodium causes the artery passageways to narrow putting more pressure on the artery walls and more fluid to be retained which denotes a larger volume of blood in the body's system which further raises blood pressure). If you don't get enough potassium in your diet or retain enough potassium, you may accumulate too much sodium in your blood.

- **Continue generating? (Y/N)**

- Drinking too much alcohol: By drinking alcohol only in moderation, generally one drink a day for women or two a day for men, you can potentially lower your blood pressure by about 4 mm Hg. Over time though, heavy drinking can damage your heart, possibly resulting in hypertension (high blood pressure) development, as well as consuming more than moderate amounts of alcohol can raise blood pressure by several points. For references, one drink equals 12 ounces of beer, five ounces of wine or 1.5 ounces of 80-proof liquor.
- Stress: Chronic stress or even just stressful moments may contribute to hypertension (high blood pressure) by creating temporary high levels of stress which can lead to a temporary increase in blood pressure. Over the long-term, these increases in blood pressure damage the arterial walls and can result in hypertension. Also, when an individual feels or perceives stress, the body releases the hormone cortisol which constricts artery passageways and interacts with the kidney to retain fluids, both of which can increase blood pressure. Stress can also cause people to try to relax by eating more, using tobacco, or drinking alcohol, all of which can increase problems with high blood pressure.

- Certain chronic conditions: Certain chronic conditions, such as kidney disease, diabetes, chronic stress, and sleep apnea, may increase your risk of high blood pressure. Some conditions may be inherited and as such may require different approaches for managing potential risk of developing hypertension (high blood pressure). If you believe a chronic condition to be the case for your situation, consult your doctor.

Facts

How many people suffer from high blood pressure? (https://www.cdc.gov/bloodpressure/about.htm?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fbloodpressure%2Ffaqs.htm)

Approximately 1 in 3 American adults have high blood pressure resulting in around 75 million American adults being affected.

What ethic group is most likely to experience high blood pressure? (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4108512/, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

African Americans have an increased prevalence of hypertension (high blood pressure) and higher complications rates. The reasons for the racial disparities in elevated blood pressure and hypertension-related risk outcomes remain unclear.

How likely is it for someone to have high blood pressure? Chances of developing high blood pressure? How many people develop high blood pressure in their lifetime? (https://www.ncbi.nlm.nih.gov/books/NBK9636/)

Hypertension (high blood pressure) generally progresses throughout an individual's lifetime. It eventually affects nearly everyone with an approximately 90% chance of developing it in a lifetime.

Are there over the counter medicines for treating high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

There are no over-the-counter medicines or drinks that can substitute for prescription medications and lifestyle modifications when it comes to treating high blood pressure. Before taking any over-the-counter medicine, drug, or supplement that claims to lower blood pressure, talk to a healthcare provider or physician. The over-the-counter medications may not work as advertised and/or interfere with other prescribed medications; in fact, some can even raise blood pressure.

Does over the counter medicine effect blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

Always read the labels on all over-the-counter medications, especially if you have hypertension (high blood pressure). If you have hypertension or high blood pressure, and especially if you are on prescription medication, consult your healthcare professional before taking any over-the-counter medications or supplements. The use of decongestants may raise blood pressure or interfere with prescribed blood pressure medications.

Will Omega-3 affect my blood pressure?
(https://www.verywellhealth.com/fish-oil-for-better-blood-pressure-89331)

Some research actually suggests that omega-3 fish oil supplements may help control blood pressure levels. Something that may affect blood pressure is over-the-counter medicine, particularly decongestants as they can raise blood pressure or interfere with prescribed blood pressure medications. Decongestants should be taken with caution if an individual has hypertension (high blood pressure).

Prevention

How do I find my own blood pressure?
(medicalnewstoday.com/articles/321429.php#checking-pressure-manually)
(Childre, D. L., & Wilson, B. (2006); Wade, C. (1975))

Blood pressure is typically measured using a sphygmomanometer and stethoscope. Using these instruments, a person can measure the contraction of the heart muscle that ejects blood during systole period, creating an increase in pressure in the arteries (known as the systolic pressure). The system also measures the pressure in the arteries during a relaxed state, known as the diastole period, right before the heart contracts (known as the diastolic pressure). The numbers from the two readings combined will generate a blood pressure reading, written as the systolic reading above the diastolic reading.

How often do you want to get your blood pressure measured?
(https://www.webmd.com/hypertension-high-blood-pressure/qa/how-often-should-i-get-my-blood-pressure-checked)

The recommended number of blood pressure measurements changes based on an individual's age, health conditions, and other factors than can potentially influence blood pressure. Normally, blood pressure should be measured each time you visit the doctor's office. For a specific number of blood pressure readings, please observe the general guidelines:

On average, if your blood pressure is less than 120/80 mm Hg (considered normal blood pressure), get it measured at least every 2 years or more frequently as your doctor suggests. If your blood pressure is borderline high (called prehypertension) -- systolic blood pressure between 120 mm Hg and 139 mm Hg or diastolic blood pressure of 80 mm Hg to 89 mm Hg -- check it at least every year or more often at your doctor's recommendation. If your reading is 140/90 mm Hg or higher, you have high blood pressure and need to see your doctor. You may need to start medication or make lifestyle changes.

Is there a cure for high blood pressure?
(https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure)

While there is no cure, using medications as prescribed and making lifestyle changes can enhance your quality of life, reduce blood pressure levels, and reduce your risk of coronary artery disease, brain hemorrhage, and kidney disease.

What are ways to manage high blood pressure? What should I do if I am not safe? What are the treatment options for high blood pressure?
(https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

In order to manage hypertension (high blood pressure), there are a few lifestyle changes that can be made to address the disease and its complications. If you currently are diagnosed with hypertension and the lifestyle changes do not work for you, you may have to take medication on a lifelong basis to manage your high blood pressure. Consult your doctor either way before implementing any changes to ensure that the issue you have is high blood pressure and not another diagnosis.

To manage or prevent high blood pressure over the long term from accruing, it is suggested to exercise regularly, lose weight, eat a healthy diet with fewer saturated fats and cholesterol, consume less sodium, quit smoking (if applicable), limit alcohol and caffeine, and reduce stress. In serious cases, it may be required to take medication.

What can I do to prevent? What can I do to avoid getting high blood pressure?
(https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

In order to prevent hypertension (high blood pressure), there are a few lifestyle changes that can be made to address the disease and its complications. The recommendations for preventing hypertension are similar for how to manage hypertension if you already have it. Consult your doctor either way before implementing any changes.

To manage or prevent high blood pressure over the long term from accruing, it is suggested to exercise regularly, lose weight, eat a healthy diet with fewer saturated fats

and cholesterol, consume less sodium, quit smoking (if applicable), limit alcohol and caffeine, and reduce stress. In serious cases, it may be required to take medication.

- Lose weight: Blood pressure often increases as weight increases resulting in hypertension (high blood pressure) because the more an individual weighs the more blood that is needed to be pumped to carry oxygen and nutrients to the tissues via the arteries. As the volume of blood circulated through arteries increases, so does the pressure on your arterial walls resulting in damage to the arteries. Being overweight also can cause sleep apnea, which further raises blood pressure. Weight loss is one of the most effective lifestyle changes for controlling hypertension.
- Eat healthy: Eating a diet that is rich in whole grains, fruits, vegetables and low-fat dairy products and skimps on saturated fat and cholesterol can lower blood pressure by up to 11 mm Hg if an individual has high blood pressure.

Continue generating? (Y/N)

- Exercise regularly: Regular physical activity — such as 150 minutes a week, or about 30 minutes most days of the week — can lower blood pressure by about 5 to 8 mm Hg if an individual has high blood pressure. It's important to be consistent because if a person stop exercising, their blood pressure can rise again. If an individual has elevated blood pressure, exercise can help avoid developing hypertension (high blood pressure). If someone already have hypertension, regular physical activity can bring blood pressure down to safer levels.

  It is also important to know that your blood pressure may increase initially after exercising but in the long-term being active can help lower blood pressure levels as well as potentially help to lose weight which is also important for managing high blood pressure. Before starting any workout regime, you should consult your doctor to ensure that it is safe to do so.

What kind of exercise is good with high blood pressure?
(Childre, D. L., & Wilson, B. (2006))
Exercise such as aerobic exercise is the generally the best exercise for individuals who have hypertension (high blood pressure) as well as for lowering blood pressure in general; examples of this type of exercise include walking, swimming and biking. Isometric exercise, like heavy weightlifting, is generally not recommended. Lighter weights with more repetition should be fine and can possibly even help with flexibility. Consult your doctor or physician for exercise recommendations.

What foods should I avoid if I have high blood pressure?

- Consume less sodium: Even a small reduction in the sodium in a diet can improve heart health and reduce blood pressure by about 5 to 6 mm Hg if an individual has high blood pressure. The effect of sodium intake on blood pressure varies among groups of people. In general, limit sodium to 2,300 milligrams (mg) a day or less; however, a lower sodium intake — 1,500 mg a day or less — is ideal for most adults. Too much salt consumption narrows the passageways of small arteries and increasing the force exerted on the arterial walls. Salt can also cause the body to retain fluid which results in more volume of blood and further raises blood pressure.
- Limit amount of alcohol: By drinking alcohol only in moderation, generally one drink a day for women or two a day for men, you can potentially lower your blood pressure by about 4 mm Hg. One drink equals 12 ounces of beer, five ounces of wine or 1.5 ounces of 80-proof liquor. Consuming more than moderate amounts of alcohol can actually raise blood pressure by several points and heavy drinking can even damage the heart.
- Quit smoking and/or tobacco use: Each cigarette an individual smokes increases their blood pressure immediately after they finish for many minutes. Not only does smoking or chewing tobacco immediately raise blood pressure, but the chemicals in tobacco can damage the lining of the artery walls; this can cause arteries to narrow and increases the risk of coronary artery disease. Additionally, secondhand smoke can increase the risk of coronary artery disease which is the leading cause of death in the US. Stopping the use of tobacco products or smoking can help blood pressure return to normal range.

Continue generating? (Y/N)

- Cut back on caffeine: The role caffeine plays in blood pressure is still debated. Caffeine can raise blood pressure up to 10 mm Hg in people who rarely consume it, but people who drink coffee regularly may experience little or no effect on their blood pressure Although the long-term effects of caffeine on blood pressure aren't clear, it's possible blood pressure may slightly increase.
- Reduce stress: Chronic stress or even just stressful moments may contribute to hypertension (high blood pressure) by creating temporary high levels of stress which can lead to a temporary increase in blood pressure. Over the long-term, these increases in blood pressure damage the artery walls and can result in hypertension. Some suggested ways to reduce stress include taking more breaks during the day, practicing meditation, or attending a yoga class. Occasional stress also can contribute to high blood pressure if an individual reacts to stress by eating unhealthy food, drinking alcohol or smoking.

What things besides diet and exercises affect blood pressure? (https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974)

Some factors that may reduce blood pressure, besides regular exercise and eating a healthy balanced diet, include consume less sodium, quit smoking (if applicable), limit alcohol and caffeine, and reduce stress.

Are eggs healthy for me to take if I had blood pressure problems?
(Wade, C. (1975))

Eating a diet that is rich in whole grains, fruits, vegetables and low-fat dairy products and skimps on saturated fat and cholesterol can lower blood pressure by up to 11 mm Hg if an individual has had high blood pressure. Additionally, losing weight can help manage high blood pressure levels and one possible way to lose weight would be to add protein, including eggs, chicken, and fish, into a diet. Protein can help a person ideally feel full throughout the day and help them reduce their total amount of food consumption. The biggest food concern with hypertension and high blood pressure is food rich in sodium and fat.

Understanding

What is blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))
Blood pressure is a component of the circulatory system and is the amount of pressure exerted on the blood as it passes through the arteries. When the left ventricle of the heart contracts it forces the blood out into the arteries; the muscular linings of the arteries resist the pressure and blood vessels are squeezed out into smaller vessels of the body. Blood pressure is the collective amount of pressure the blood is under as a result of the pumping heart, resistance of arterial walls, and the closing of the heart valves. Overall, this pressure is maintained by the contraction and relaxation of the arteries and the pumping of the heart (the contraction is the systolic pressure and the relaxation is the diastolic pressure).

What is a healthy blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Blood pressure numbers of less than 120/80 mm Hg are considered normal for the majority of people. Since no two people are exactly alike, including potential force of heartbeat and activity of arterioles, there is some range to what can be considered normal for healthy individuals.

Can blood pressure vary?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Blood pressure varies, quite normally, at different times for individuals (i.e., it can increase temporary during physical activity or decrease during sleep).

Is the recommended blood pressure appropriate for everybody?
(https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings)

The ideal blood pressure is generally consistent for everyone with a normal reading containing values lower than 120/80 mm Hg (read as '120 over 80'). There have been discrepancies in the recent health literature regarding the normal ranges for individuals in different age groups. It has been suggested that the ideal blood pressure values are different for older individuals. (As people age, the stress they may incur in their life may be a reason to suggest lower blood pressure levels).

High Blood Pressure

What is a high blood pressure?
(or) What is high blood pressure?
(https://ihealthlabs.com/Bloodpressure, (Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

There are four general stages of high blood pressure that include elevated blood pressure, hypertension stage 1, hypertension stage 2, and hypertension crisis. The most common type of high blood pressure diagnosis is known as essential or idiopathic hypertension, consists of these aforementioned stages, and affects 90-95% of the people who are diagnosed with high blood pressure. Below are the four stages:

1. Elevated blood pressure
   - Elevated blood pressure is when readings consistently range from 120-129 systolic and less than 80 mm Hg diastolic. People with elevated blood pressure are likely to develop high blood pressure unless steps are taken to control the condition.

2. Hypertension Stage 1
   - Hypertension Stage 1 is when blood pressure consistently ranges from 130-139 systolic or 80-89 mm Hg diastolic. At this stage of high blood pressure, doctors are likely to prescribe lifestyle changes and may consider adding blood pressure medication based on your risk of atherosclerotic cardiovascular diseases (ASCVD), myocardial infraction or brain hemorrhage.

3. Hypertension Stage 2
   - Hypertension Stage 2 is when blood pressure consistently ranges from 140/90 mm Hg or higher. At this stage of hypertension, doctors are likely to prescribe a combination of blood pressure medications and lifestyle changes to decrease the risk of complications like brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure.

Continue generating? (Y/N)

4. Hypertensive crisis
    - This stage of hypertension requires medical attention. If your blood pressure readings suddenly exceed 180/120 mm Hg, wait five minutes and then test your blood pressure again to see if it is not a temporary increase. If your readings are still unusually high or if you are also experiencing signs of possible organs damage such as chest pain, shortness of breath, numbness, change in vision or difficulty speaking, call 911 immediately. You could be experiencing a hypertensive crisis.

Is high blood pressure worse than low pressure? (https://www.cheatsheet.com/health-fitness/which-is-more-dangerous-high-blood-pressure-or-low-blood-pressure.html/)

Generally, hypertension (high blood pressure) is more concerning than hypotension (low blood pressure) as its symptoms and complications can cause lasting damage to the body via brain hemorrhage, myocardial infarction, coronary artery disease, or kidney failure. This may not always be the case as hypotension can cause dizziness and fainting which could result in serious injury. Conditions are very dependent on the situation and the individual, especially considering factors such as age, gender, race, family history, etc.

When do men start to see an increase in blood pressure? Are men more likely to have high blood pressure than women? (https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea. Until about age 64, high blood pressure is observed more commonly in men. This switches around 65 when high blood pressure becomes more prevalent in women.

When do women start to see an increase in blood pressure? (https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea. Until about age 64, high blood pressure is observed more often in men. This switches around 65 when high blood pressure is then more common in women with African American women aged 65 having the highest incidence rate of high blood pressure.

How many women/men between the ages of 35-44 have high blood pressure? Can young people have high blood pressure?
(https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea.

Approximately 20% of women between the ages of 35-44 will have developed high blood pressure. Approximately 25% of men between the ages of 35-44 will have developed high blood pressure.

What is high blood pressure called?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

From a medical perspective, high blood pressure is termed hypertension, or sometimes essential hypertension, while low blood pressure is termed hypotension.

Low Blood Pressure
Is there such a thing as low blood pressure? What is low blood pressure? Is it possible to have low blood pressure (i.e., hypotension)? If so, what would be considered a low blood pressure reading?
(https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1)

Hypotension (low blood pressure) is a blood pressure reading of less than 90/60. Severely low blood pressure can be a sign of an underlying problem -- especially in the elderly -- where it may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs.

What is bad about low blood pressure?
(https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1, https://www.healthline.com/health/hypotension#types)

In healthy individuals, hypotension (low blood pressure) without any symptoms is not usually a concern and does not need to be treated. Hypotension with symptoms can be a concern as it can cause dizziness, weakness, fainting and a risk of injury from falls. Severely low blood pressure can be a sign of an underlying problem -- especially in the elderly -- where it may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs.

What are symptoms of low blood pressure?

(https://www.heart.org/en/health-topics/high-blood-pressure/the-facts-about-high-blood-pressure/low-blood-pressure-when-blood-pressure-is-too-low, Childre, D. L., & Wilson, B. (2006))

Hypotension (low blood pressure) can include symptoms such as lightheadedness, vertigo, fainting (syncope), blurred vision, fatigue, or lack of concentration. Severely low blood pressure may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs. These complications and problems are especially concerning for elderly individuals.

Systolic/Diastolic

What are the two types of blood pressure?
What number is high/low? What is the difference between systolic and diastolic?
What does the top/bottom number mean? What do the two numbers mean?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart. Diastolic is the bottom number and it represents the minimum pressure of blood in the arteries, or maximum relaxation, where the heart is relaxing between beats before pumping more blood into the system.

What is more important — the Systolic or Diastolic reading?
(Galton, L. (1973))

Both readings are important; the systolic reading measures an individual's blood pressure during a heart contraction and the diastolic reading measures blood pressure between heart contractions (or when it is resting). The two readings combined, with systolic on top and diastolic on bottom, are used to produce a blood pressure reading, and if either one or both are higher than the normal range, they can indicate potential issues and complications.

Are they independent?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Systolic and diastolic readings are not independent as they indicate opposite functions of the heart contracting and relaxing and the pressure in the arteries during these functions. Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart. Diastolic is the bottom number and it represents the minimum pressure of blood in the

arteries, or maximum relaxation, where the heart is relaxing between beats before pumping more blood into the system.

What is systolic blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart.

What is diastolic blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Diastolic is the bottom number and it represents the minimum pressure of blood in the arteries, or maximum relaxation, where the heart is relaxing between beats before pumping more blood into the system.

Appendix D: Conversational and Technical Chatbot Answers

Introduction

Hello, my name is MedMind GPT. I'm here to help you learn about blood pressure today. You can ask questions about understanding blood pressure, learning how to manage or prevent it, who is affected, and more. What is your first question?

Generic

I am sorry, I am unable to answer that question. I am only trained to answer questions related to blood pressure topics. Do you have questions regarding blood pressure?

I am sorry, I am unable to answer that question. Do you have another question about blood pressure?

I am sorry but it does not appear that I have an answer for that. I will look into that in the future. Do you have another question about blood pressure?

I am only a chatbot and I don't know quite know what you are asking. Can you please ask your question in a different way?

I am only a chatbot and I don't know how to answer your question. Can you please ask your question in a different way?

If participant responds "No" to any of the (Y/N) questions, say:

Where can I find more information about high blood pressure?
The American Heart Association has more information on blood pressure if you wish to explore more later. I cannot currently send you there.

Risk

Why should I care?
(https://www.webmd.com/hypertension-high-blood-pressure/5-misconceptions-about-hypertension; https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Wade, C. (1975))

Hypertension is the largest single causative factor in all deaths. Hypertension (high blood pressure) causes the arterioles to tighten, resulting in the heart having to work harder to pump blood through the tissues to extremities and vital organs at a normal rate.

Let me know if you would like me to provide important details for why hypertension is harmful, or if you want, you can ask another question.

Hypertension is a dangerous ailment because of its effect on the walls of arteries. Hypertension accelerates the ailment of atherosclerosis which causes the arteries to harden and reduces the elasticity of the affected arteries. Over time, this hardening can have detrimental effects including increased risk of brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure.

What are the risk factors?
(https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Wade, C. (1975))

Hypertension (high blood pressure) is a dangerous ailment because of its effect on the walls of arteries. It accelerates the ailment of atherosclerosis which causes the arteries to harden and reduces the elasticity of the affected arteries.

I can explain why this is harmful over time if you want, or you can ask another question.

Over time, this hardening can have detrimental effects including, but not limited to, increased risk of brain hemorrhage, myocardial infarction, coronary artery disease (3x more likely), and kidney complications. Coronary artery disease and brain hemorrhage are the first and fifth leading cause of death in the United States.

What are comorbidities with high blood pressure?
(Kaplan, N. M., & Lieberman, E. (1979))

Some possible factors that may be observed simultaneously or in conjunction with high blood pressure include high cholesterol, obesity, or diabetes.

Please inform me if you need more information about diseases that can be found alongside hypertension, or if you prefer, ask a different question.

Increased incidences of the following diseases have been found when hypertension (high blood pressure) is presence: uterine fibromyomas, gout, quadriplegia, menopause, and polycythemia (slow growing blood cancer). Research is still needed to learn about these diseases and their connection to high blood pressure.

Symptoms
What are symptoms? What are symptoms of high blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Hypertension (high blood pressure) is particularly dangerous as it is generally symptomless. Individuals can have it for years without knowing.
If you are curious to know more, choose from the following facts:

- The number of people in America who have high blood pressure but are unaware of it.
- The nickname health professionals have given hypertension.
- The reason individuals cannot identify hypertension through symptoms

However, if you would like to move on, please ask a different question.

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

Fact 1: One in three Americans with hypertension are not consciously aware of having developed it.

Fact 2: The absence of symptoms gives hypertension its name: the "silent" killer

Fact 3: Many of the possible symptoms of hypertension (e.g., headaches, vertigo, light-headedness, nosebleeds) are just as common in people with normal blood pressure. Symptoms simply cannot be relied upon as early warning signs of hypertension.

Thank you for interest in becoming more educated about high blood pressure. If you are curious to continue to learn more, choose from the following facts:

- The number of people in America who have high blood pressure but are unaware of it.
- The nickname health professionals have given hypertension.
- The reason individuals cannot identify hypertension through symptoms

However, if you would like to move on, please ask a different question.

How can you tell if you have high blood pressure? How do I know if I have high blood pressure?
(Wade, C. (1975))

The best way to determine if an individual has hypertension (high blood pressure) is through regular checkups.

I am available to provide more information on the difficulty of self-diagnosis for hypertension. Otherwise, please feel free to ask your next question.

Many of the symptoms of hypertension (e.g., headaches, vertigo, light-headedness, nosebleeds) are just as commonly in people with normal blood pressure. Symptoms simply cannot be relied upon as early warning signs of hypertension. That is why it is best to go to your doctor for regular checkups.

Causes

What affects blood pressure? What causes high blood pressure?
(https://www.webmd.com/hypertension-high-blood-pressure/guide/blood-pressure-causes#1, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

The specific cause of hypertension is unknown, but several factors may play a role including age, race, family history, weight, tobacco consumption, being physically inactive, stress, sodium, potassium, alcohol, and certain chronic conditions.

Choose from the following factors associated with hypertension to discuss further in depth:

- Age
- Race
- Family history
- Weight
- Tobacco consumption
- Being physically inactive
- Sodium consumption
- Potassium consumption
- Alcohol consumption
- Stress
- Certain chronic conditions

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

- Age: The risk of high blood pressure increases as an individual ages with an approximately 90% chance of developing high blood pressure in a lifetime. The

stress an individual incurs in life results in higher blood pressure levels along with the loss in elasticity of the arteries due to an increased age.

- Race: Hypertension (high blood pressure) is particularly common among people of African heritage, often developing at an earlier age than it does in Caucasians. Serious complications, such as brain hemorrhage, myocardial infraction, and kidney failure, are also more common in people of African heritage potentially due to this increase prevalence of hypertension although the exact reason for the racial disparity remains unclear.
- Family history: Hypertension (high blood pressure) can be genetic; it tends to run in families particularly as a comorbidity of other hereditary diseases that may have hypertension as a complication such as diabetes.
- Being overweight or obese: The more an individual weighs the more blood carrying oxygen and nutrients to their tissues they need to supply via the arteries. As the volume of blood circulated through the arteries increases, so does the pressure on the artery walls resulting in damage to the arteries. The heart also has to work harder to pump more blood through a larger body causing an increased risk for hypertension (high blood pressure) as well as coronary heart disease and myocardial infraction.
- Not being physically active: People who are inactive tend to have higher heart rates, creating strain on the heart to contract and relax more frequently. The higher a heart rate is, the harder the heart must work with each contraction resulting in a stronger force on the arteries; this strong force causes the slow deterioration of the arteries walls and their elasticity. Lack of physical activity also increases the risk of being overweight if not managed with a proper diet. It is also important to understand that blood pressure may increase temporarily initially after exercising but in the long-term, being active can help lower blood pressure levels as well as potentially help lose weight which is also important for managing blood pressure. Before starting any workout regime though, you should consult your doctor to ensure that it is safe to do so.
- Using tobacco: Not only does smoking or chewing tobacco immediately raise blood pressure temporarily, but the chemicals in tobacco can damage the lining of the arterial walls. This can cause arteries to narrow and increases the risk of coronary artery disease; secondhand smoke also can increase the risk of coronary artery disease. Coronary artery disease is the leading cause of death in the US.
- Too much sodium (salt) in your diet: Too much sodium consumption narrows the passageways of small arteries by causing arterioles to swell and therefore results in exerting more force on the arterial walls. Too much sodium in a diet also causes the body to retain fluid which results in more volume of blood and further raises blood pressure which in turn strains the heart.

- Too little potassium in your diet: Potassium helps balance the amount of sodium in your cells (sodium causes the artery passageways to narrow putting more pressure on the artery walls and more fluid to be retained which denotes a larger volume of blood in the body's system which further raises blood pressure). If you don't get enough potassium in your diet or retain enough potassium, you may accumulate too much sodium in your blood.
- Drinking too much alcohol: By drinking alcohol only in moderation, generally one drink a day for women or two a day for men, you can potentially lower your blood pressure by about 4 mm Hg. Over time though, heavy drinking can damage your heart, possibly resulting in hypertension (high blood pressure) development, as well as consuming more than moderate amounts of alcohol can raise blood pressure by several points. For references, one drink equals 12 ounces of beer, five ounces of wine or 1.5 ounces of 80-proof liquor.
- Stress: Chronic stress or even just stressful moments may contribute to hypertension (high blood pressure) by creating temporary high levels of stress which can lead to a temporary increase in blood pressure. Over the long-term, these increases in blood pressure damage the arterial walls and can result in hypertension. Also, when an individual feels or perceives stress, the body releases the hormone cortisol which constricts artery passageways and interacts with the kidney to retain fluids, both of which can increase blood pressure. Stress can also cause people to try to relax by eating more, using tobacco, or drinking alcohol, all of which can increase problems with high blood pressure.
- Certain chronic conditions: Certain chronic conditions, such as kidney disease, diabetes, chronic stress, and sleep apnea, may increase your risk of high blood pressure. Some conditions may be inherited and as such may require different approaches for managing potential risk of developing hypertension (high blood pressure). If you believe a chronic condition to be the case for your situation, consult your doctor.

If you want to continue our conversation discussing factors associated with hypertension, choose from the following:

- Age
- Race
- Family history
- Weight
- Tobacco consumption
- Being physically inactive

- Sodium consumption
- Potassium consumption
- Alcohol consumption
- Stress
- Certain chronic conditions

Facts

How many people suffer from high blood pressure? (https://www.cdc.gov/bloodpressure/about.htm?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fbloodpressure%2Ffaqs.htm)

Approximately 1 in 3 American adults have high blood pressure resulting in around 75 million American adults being affected.

What ethic group is most likely to experience high blood pressure? (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4108512/, Kaplan, N. M., & Lieberman, E. (1979); Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

African Americans have an increased prevalence of hypertension (high blood pressure) and higher complications rates. The reasons for the racial disparities in elevated blood pressure and hypertension-related risk outcomes remain unclear.

How likely is it for someone to have high blood pressure? Chances of developing high blood pressure? How many people develop high blood pressure in their lifetime? (https://www.ncbi.nlm.nih.gov/books/NBK9636/)

Hypertension (high blood pressure) generally progresses throughout an individual's lifetime. It eventually affects nearly everyone with an approximately 90% chance of developing it in a lifetime.

Are there over the counter medicines for treating high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

There are no over-the-counter medicines or drinks that can substitute for prescription medications and lifestyle modifications when it comes to treating high blood pressure. Before taking any over-the-counter medicine, drug, or supplement that claims to lower blood pressure, talk to a healthcare provider or physician.

If you want, I can explain why there needs to be precaution for this type of medicine. Or you can ask another question about hypertension.

The over-the-counter medications may not work as advertised and/or interfere with other prescribed medications; in fact, some can even raise blood pressure.

Does over the counter medicine effect blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

Always read the labels on all over-the-counter medications, especially if you have hypertension (high blood pressure). If you have hypertension or high blood pressure, and especially if you are on prescription medication, consult your healthcare professional before taking any over-the-counter medications or supplements.

I can provide an example of an over-the-counter medication that can affect blood pressure. If you want to learn about something else, please ask your next question.

Decongestant medication is to be avoided if you have high blood pressure. The use of decongestants may raise blood pressure or interfere with prescribed blood pressure medications.

Will Omega-3 affect my blood pressure?
(https://www.verywellhealth.com/fish-oil-for-better-blood-pressure-89331)

Some research actually suggests that omega-3 fish oil supplements may help control blood pressure levels. Other research has not found a correlation

I can go further in depth as to why over-the-counter medicine should be limited, or if you want to move on, please as another question.

Something that may affect blood pressure is over-the-counter medicine, particularly decongestants as they can raise blood pressure or interfere with prescribed blood pressure medications. Decongestants should be taken with caution if an individual has hypertension (high blood pressure).

Prevention
How do I find my own blood pressure?
(medicalnewstoday.com/articles/321429.php#checking-pressure-manually)
(Childre, D. L., & Wilson, B. (2006); Wade, C. (1975))

Choose from the following to learn how to find your blood pressure:

- Instruments to measure blood pressure

- Systolic blood pressure
- Diastolic blood pressure
- Generating a blood pressure reading

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

Instruments to measure blood pressure:
Blood pressure is typically measured using a sphygmomanometer and stethoscope. Using these instruments, a person can measure the contraction of the heart muscle that ejects blood as well as the pressure in the arteries during a relaxed state.

Systolic blood pressure:
The systolic pressure is the increase pressure in the arteries as the heart contracts, to eject blood (known as the systole period). This number goes in the numerator of a blood pressure reading.

Diastolic blood pressure:
The diastolic pressure is the pressure in the arteries during a relaxed state, right before the heart contracts (known as the diastole period). This number goes in the denominator of a blood pressure reading.

Generating a blood pressure reading:
The numbers from the two readings (systolic pressure and diastolic pressure) combined will generate a blood pressure reading, written as the systolic reading above the diastolic reading.

If you want to continue knowing more about how to find your blood pressure, choose from the following:

- Instruments to measure blood pressure
- Systolic blood pressure
- Diastolic blood pressure
- Generating a blood pressure reading

If you are ready to move on, please ask a different question.

Is there a cure for high blood pressure?
(https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure)

While there is no cure, using medications as prescribed and making lifestyle changes can enhance your quality of life, reduce blood pressure levels, and reduce your risk of coronary artery disease, brain hemorrhage, and kidney disease.

What are ways to manage high blood pressure? What should I do if I am not safe? What are the treatment options for high blood pressure?
(https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

In order to manage hypertension (high blood pressure), there are a few lifestyle changes that can be made to address the disease and its complications. If you currently are diagnosed with hypertension and the lifestyle changes do not work for you, you may have to take medication on a lifelong basis to manage your high blood pressure. Consult your doctor either way before implementing any changes to ensure that the issue you have is high blood pressure and not another diagnosis.

Please let me know if you want more details on how to manage and prevent hypertension, or if you would like to move on, please ask your next question.

To manage or prevent high blood pressure over the long term from accruing, it is suggested to exercise regularly, lose weight, eat a healthy diet with fewer saturated fats and cholesterol, consume less sodium, quit smoking (if applicable), limit alcohol and caffeine, and reduce stress. In serious cases, it may be required to take medication.

How often do you want to get your blood pressure measured?
(https://www.webmd.com/hypertension-high-blood-pressure/qa/how-often-should-i-get-my-blood-pressure-checked)

The recommended number of blood pressure measurements changes based on an individual's age, health conditions, and other factors than can potentially influence blood pressure. Normally, blood pressure should be measured each time you visit the doctor's office.

To know more about the general guidelines based on the average frequencies you need to your doctor for various blood pressure readings, choose from the following:

- Less than 120/80 mm Hg
- Diastolic blood pressure is between 80 mm Hg to 89 mm Hg
- Systolic blood pressure is between 120 mm Hg and 139 mm Hg
- Higher or equal to 140/90 mm Hg

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

- If your blood pressure is less than 120/80 mm Hg, (considered normal blood pressure), get it measured at least every 2 years or more at your doctor's recommendation.
- If your diastolic blood pressure is between 80 mm Hg to 89 mm Hg, get it measured at least every year or more often at your doctor's recommendation.
- If your systolic blood pressure is between 120 mm Hg and 139 mm Hg, get it measured at least every year or more often at your doctor's recommendation.
- If your reading is 140/90 mm Hg or higher, you have high blood pressure and need to see your doctor. You may need to start medication or make lifestyle changes.

If you want to continue to know more about the general guidelines based on the average frequencies you need to your doctor for various blood pressure readings, choose from the following:

- Less than 120/80 mm Hg
- Diastolic blood pressure is between 80 mm Hg to 89 mm Hg
- Systolic blood pressure is between 120 mm Hg and 139 mm Hg
- Higher or equal to 140/90 mm Hg

What can I do to prevent? What can I do to avoid getting high blood pressure?
(https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974, Galton, L. (1973); Childre, D. L., & Wilson, B. (2006))

In order to prevent hypertension (high blood pressure), there are a few lifestyle changes that can be made to address the disease and its complications. The recommendations for preventing hypertension are similar for how to manage hypertension if you already have it. Consult your doctor either way before implementing any changes.

To manage or prevent high blood pressure, choose from the following topics to learn more about preventing high blood pressure:

- Losing weight
- Eating healthy
- Exercising regularly
- Reducing Stress

- Quit smoking and/or tobacco use

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

- Lose weight: Blood pressure often increases as weight increases resulting in hypertension (high blood pressure) because the more an individual weighs the more blood that is needed to be pumped to carry oxygen and nutrients to the tissues via the arteries. As the volume of blood circulated through arteries increases, so does the pressure on your arterial walls resulting in damage to the arteries. Being overweight also can cause sleep apnea, which further raises blood pressure. Weight loss is one of the most effective lifestyle changes for controlling hypertension.
- Eat healthy: Eating a diet that is rich in whole grains, fruits, vegetables and low-fat dairy products and skimps on saturated fat and cholesterol can lower blood pressure by up to 11 mm Hg if an individual has high blood pressure.
- Exercise regularly: Regular physical activity — such as 150 minutes a week, or about 30 minutes most days of the week — can lower blood pressure by about 5 to 8 mm Hg if an individual has high blood pressure. It's important to be consistent because if a person stop exercising, their blood pressure can rise again. If an individual has elevated blood pressure, exercise can help avoid developing hypertension (high blood pressure). If someone already have hypertension, regular physical activity can bring blood pressure down to safer levels. It is also important to know that your blood pressure may increase initially after exercising but in the long-term being active can help lower blood pressure levels as well as potentially help to lose weight which is also important for managing high blood pressure. Before starting any workout regime, you should consult your doctor to ensure that it is safe to do so.
- Reduce stress: Chronic stress or even just stressful moments may contribute to hypertension (high blood pressure) by creating temporary high levels of stress which can lead to a temporary increase in blood pressure. Over the long-term, these increases in blood pressure damage the artery walls and can result in hypertension. Some suggested ways to reduce stress include taking more breaks during the day, practicing meditation, or attending a yoga class. Occasional stress also can contribute to high blood pressure if an individual reacts to stress by eating unhealthy food, drinking alcohol or smoking.

- Quit smoking and/or tobacco use: Each cigarette an individual smokes increases their blood pressure immediately after they finish for many minutes. Not only does smoking or chewing tobacco immediately raise blood pressure, but the chemicals in tobacco can damage the lining of the artery walls; this can cause arteries to narrow and increases the risk of coronary artery disease. Additionally, secondhand smoke can increase the risk of coronary artery disease which is the leading cause of death in the US. Stopping the use of tobacco products or smoking can help blood pressure return to normal range.

If you want to continue knowing more about how to manage or prevent high blood pressure, choose from the following topics:

- Losing weight
- Eating healthy
- Exercising regularly
- Reducing Stress
- Quit smoking and/or tobacco use

What kind of exercise is good with high blood pressure?

(Childre, D. L., & Wilson, B. (2006))

Exercise such as aerobic exercise is the generally the best exercise for individuals who have hypertension (high blood pressure) as well as for lowering blood pressure in general; examples of this type of exercise include walking, swimming and biking.

Please let me know if you are interested in knowing other forms of exercises that are not recommended. Otherwise, please ask your next question.

Isometric exercise, like heavy weightlifting, is generally not recommended. Lighter weights with more repetition should be fine and can possibly even help with flexibility. Consult your doctor or physician for exercise recommendations.

What foods should I avoid if I have high blood pressure?

To avoid high blood pressure in your diet, it is recommended to consume less sodium, limit the amount of alcohol, and quit smoking and/or tobacco use.

To delve further in this topic, choose what you would like to know more about:

- Why you should consume less sodium in your diet.
- Why you should limit the amount of alcohol in your diet.

- Why you should quit smoking and/or tobacco use.
- Why you should limit consumption of caffeine

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

- Consume less sodium: Even a small reduction in the sodium in a diet can improve heart health and reduce blood pressure by about 5 to 6 mm Hg if an individual has high blood pressure. The effect of sodium intake on blood pressure varies among groups of people. In general, limit sodium to 2,300 milligrams (mg) a day or less; however, a lower sodium intake — 1,500 mg a day or less — is ideal for most adults. Too much salt consumption narrows the passageways of small arteries and increasing the force exerted on the arterial walls. Salt can also cause the body to retain fluid which results in more volume of blood and further raises blood pressure.
- Limit amount of alcohol: By drinking alcohol only in moderation, generally one drink a day for women or two a day for men, you can potentially lower your blood pressure by about 4 mm Hg. One drink equals 12 ounces of beer, five ounces of wine or 1.5 ounces of 80-proof liquor. Consuming more than moderate amounts of alcohol can actually raise blood pressure by several points and heavy drinking can even damage the heart.
- Quit smoking and/or tobacco use: Each cigarette an individual smokes increases their blood pressure immediately after they finish for many minutes. Not only does smoking or chewing tobacco immediately raise blood pressure, but the chemicals in tobacco can damage the lining of the artery walls; this can cause arteries to narrow and increases the risk of coronary artery disease. Additionally, secondhand smoke can increase the risk of coronary artery disease which is the leading cause of death in the US. Stopping the use of tobacco products or smoking can help blood pressure return to normal range.
- Cut back on caffeine: The role caffeine plays in blood pressure is still debated. Caffeine can raise blood pressure up to 10 mm Hg in people who rarely consume it, but people who drink coffee regularly may experience little or no effect on their blood pressure Although the long-term effects of caffeine on blood pressure aren't clear, it's possible blood pressure may slightly increase.

To continue learning more about this topic, choose what you would like to know:

- Why you should consume less sodium in your diet.
- Why you should limit the amount of alcohol in your diet.
- Why you should quit smoking and/or tobacco use.
- Why you should limit consumption of caffeine

What things besides diet and exercises affect blood pressure?
(https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/high-blood-pressure/art-20046974)
Some factors that may reduce blood pressure, besides regular exercise and eating a healthy balanced diet, include consume less sodium, quit smoking (if applicable), limit alcohol and caffeine, and reduce stress.

Are eggs healthy for me to take if I had blood pressure problems?
(Wade, C. (1975))

Eating a diet that is rich in whole grains, fruits, vegetables and low-fat dairy products and skimps on saturated fat and cholesterol can lower blood pressure by up to 11 mm Hg if an individual has had high blood pressure. Additionally, losing weight can help manage high blood pressure levels and one possible way to lose weight would be to add protein, including eggs, chicken, and fish, into a diet. Protein can help a person ideally feel full throughout the day and help them reduce their total amount of food consumption.

I can summarize the biggest food concerns with hypertension, however, if you would like to move on to your next question, please just ask.

The biggest food concern with hypertension and high blood pressure is food rich in sodium and fat.

Understanding
What is blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))
Blood pressure is a component of the circulatory system and is the amount of pressure exerted on the blood as it passes through the arteries. When the left ventricle of the heart contracts it forces the blood out into the arteries; the muscular linings of the arteries resist the pressure and blood vessels are squeezed out into smaller vessels of the body.

I am available to offer more explanation on this matter. If not, please ask your next question.

Blood pressure is the collective amount of pressure the blood is under as a result of the pumping heart, resistance of arterial walls, and the closing of the heart valves. Overall, this pressure is maintained by the contraction and relaxation of the arteries and the pumping of the heart (the contraction is the systolic pressure and the relaxation is the diastolic pressure).

What is a healthy blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Blood pressure numbers of less than 120/80 mm Hg are considered normal for the majority of people.

I can provide more context if you want, or you can ask another question.

Since no two people are exactly alike, including potential force of heartbeat and activity of arterioles, there is some range to what can be considered normal for healthy individuals.

Can blood pressure vary?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Blood pressure varies, quite normally, at different times for individuals (i.e., it can increase temporary during physical activity or decrease during sleep).

Is the recommended blood pressure appropriate for everybody?
(https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings)

The ideal blood pressure is generally consistent for everyone with a normal reading containing values lower than 120/80 mm Hg (read as '120 over 80').

However, there are discrepancies in recent health literature about normal blood pressure for individuals if you are interested in knowing. If not, please ask another question.

There have been discrepancies in the recent health literature regarding the normal ranges for individuals in different age groups. It has been suggested that the ideal blood pressure values are different for older individuals. (As people age, the stress they may incur in their life may be a reason to suggest lower blood pressure levels).

High Blood Pressure
What is a high blood pressure?
(or) What is high blood pressure?

(https://ihealthlabs.com/Bloodpressure, (Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

There are four general stages of high blood pressure that include elevated blood pressure, hypertension stage 1, hypertension stage 2, and hypertension crisis. The most common type of high blood pressure diagnosis is known as essential or idiopathic hypertension, consists of these aforementioned stages, and affects 90-95% of the people who are diagnosed with high blood pressure.

Choose from the following to go more in depth about the different stages of hypertension:

- Elevated blood pressure
- Hypertension Stage 1
- Hypertension Stage 2
- Hypertensive crisis

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

5. Elevated blood pressure
    - Elevated blood pressure is when readings consistently range from 120-129 systolic and less than 80 mm Hg diastolic. People with elevated blood pressure are likely to develop high blood pressure unless steps are taken to control the condition.

6. Hypertension Stage 1
    - Hypertension Stage 1 is when blood pressure consistently ranges from 130-139 systolic or 80-89 mm Hg diastolic. At this stage of high blood pressure, doctors are likely to prescribe lifestyle changes and may consider adding blood pressure medication based on your risk of atherosclerotic cardiovascular diseases (ASCVD), myocardial infraction or brain hemorrhage.

7. Hypertension Stage 2
    - Hypertension Stage 2 is when blood pressure consistently ranges from 140/90 mm Hg or higher. At this stage of hypertension, doctors are likely to prescribe a combination of blood pressure medications and lifestyle changes to decrease the risk of complications like brain hemorrhage, myocardial infarction, coronary artery disease, and kidney failure.

8. Hypertensive crisis

- This stage of hypertension requires medical attention. If your blood pressure readings suddenly exceed 180/120 mm Hg, wait five minutes and then test your blood pressure again to see if it is not a temporary increase. If your readings are still unusually high or if you are also experiencing signs of possible organs damage such as chest pain, shortness of breath, numbness, change in vision or difficulty speaking, call 911 immediately. You could be experiencing a hypertensive crisis.

If you would like to continue learning more about the different stages of hypertension, choose from the following:

1) Elevated blood pressure
2) Hypertension Stage 1
3) Hypertension Stage 2
4) Hypertensive crisis

Is high blood pressure worse than low pressure?
(https://www.cheatsheet.com/health-fitness/which-is-more-dangerous-high-blood-pressure-or-low-blood-pressure.html/)

Generally, hypertension (high blood pressure) is more concerning than hypotension (low blood pressure) as its symptoms and complications can cause lasting damage to the body via brain hemorrhage, myocardial infarction, coronary artery disease, or kidney failure.

I can go further into the nuances of the dangers of low blood pressure, or if you want me to ask a different question, please feel free to ask.

There can be nuances as low blood pressure may not always be the case as hypotension can cause dizziness and fainting which could result in serious injury. Conditions are very dependent on the situation and the individual, especially considering factors such as age, gender, race, family history, etc.

Are men more likely to have high blood pressure than women?
(https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)
High blood pressure is more frequently observed in men until around the age of 64, but after reaching the age of 65, it becomes more prevalent in women.

When do men start to see an increase in blood pressure?
(https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea.

I can provide more context at the rates of which blood pressure is more common between men and women, or if you would like, I can answer another question.

Until about age 64, high blood pressure is observed more commonly in men. This switches around 65 when high blood pressure becomes more prevalent in women

When do women start to see an increase in blood pressure?
(https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea.

I can provide more context at the rates of which blood pressure is more common between men and women, or if you would like, I can answer another question.

At around age 65, high blood pressure becomes more common among women, particularly African American women, who have the highest incidence rate of high blood pressure in this age group. However, up until approximately age 64, high blood pressure is more frequently observed in men.

How many women/men between the ages of 35-44 have high blood pressure? Can young people have high blood pressure?
(https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

Hypertension and higher blood pressure levels begin to rise around the age of 40 for most people (men and women) although it is possible to experience high blood pressure when individuals are younger or if they have a chronic condition like diabetes or sleep apnea.

I am equipped with some statistics on this subject if you are interested, but if you are ready to explore another topic about high blood pressure, please ask.

Approximately 20% of women between the ages of 35-44 will have developed high blood pressure. Approximately 25% of men between the ages of 35-44 will have developed high blood pressure.

What is high blood pressure called?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

From a medical perspective, high blood pressure is termed hypertension, or sometimes essential hypertension, while low blood pressure is termed hypotension.

Low Blood Pressure

Is there such a thing as low blood pressure? What is low blood pressure? Is it possible to have low blood pressure (i.e., hypotension)? If so, what would be considered a low blood pressure reading?
(https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1)

Hypotension (low blood pressure) is a blood pressure reading of less than 90/60.

I can explain the dangers of low blood pressure further, but please feel free to ask another question if you want to move on.

Severely low blood pressure can be a sign of an underlying problem -- especially in the elderly -- where it may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs.

What is bad about low blood pressure?
(https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1, https://www.healthline.com/health/hypotension#types)

In healthy individuals, hypotension (low blood pressure) without any symptoms is not usually a concern and does not need to be treated. Hypotension with symptoms can be a concern as it can cause dizziness, weakness, fainting and a risk of injury from falls.

Should you want to know why this can be a sign of an underlying problem, I can go further in depth. Or if you want to ask a different question, please go ahead.

Severely low blood pressure can be a sign of an underlying problem -- especially in the elderly -- where it may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs.

What are symptoms of low blood pressure?
(https://www.heart.org/en/health-topics/high-blood-pressure/the-facts-about-high-blood-pressure/low-blood-pressure-when-blood-pressure-is-too-low, Childre, D. L., & Wilson, B. (2006))

Hypotension (low blood pressure) can include symptoms such as lightheadedness, vertigo, fainting (syncope), blurred vision, fatigue, or lack of concentration. Severely low

blood pressure may cause inadequate blood flow and deprive the body of enough oxygen to carry out its normal functions resulting in damage to the heart, brain, and other vital organs.

For a better understanding of who is most affected by low blood pressure, I can provide more details. But if you are inclined to move on to another question, please proceed.

These complications and problems are especially concerning for elderly individuals.

Systolic/Diastolic

What are the two types of blood pressure?
What number is high/low? What is the difference between systolic and diastolic?
What does the top/bottom number mean? What do the two numbers mean?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

The two types of blood pressure are systolic pressure (the top number) and diastolic pressure (the bottom number).

I am prepared to offer a more in-depth explanation of the two types of blood pressures, but feel free to ask another question.

Systolic Pressure:
Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart.

Diastolic Pressure:
Diastolic is the bottom number and it represents the minimum pressure of blood in the arteries, or maximum relaxation, where the heart is relaxing between beats before pumping more blood into the system.

What is more important — the Systolic or Diastolic reading?
(Galton, L. (1973))

Both readings are important; the systolic reading measures an individual's blood pressure during a heart contraction and the diastolic reading measures blood pressure between heart contractions (or when it is resting).
For more understanding about the two blood pressure readings, I can go further in depth, or you can ask another question.

The two readings combined, with systolic on top and diastolic on bottom, are used to produce a blood pressure reading, and if either one or both are higher than the normal range, they can indicate potential issues and complications.

Are they independent?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Systolic and diastolic readings are not independent as they indicate opposite functions of the heart contracting and relaxing and the pressure in the arteries during these functions.

Should you like a more in-depth explanation, I can provide more information. However, please feel free to ask a new question.

Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart. Diastolic is the bottom number and it represents the minimum pressure of blood in the arteries, or maximum relaxation, where the heart is relaxing between beats before pumping more blood into the system.

What is systolic blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Systolic is the top number and it represents the maximum pressure in your arteries as your heart contracts to pump blood to the body from the left ventricle of your heart.

If you desire for me to phrase this more simply, I can. Or you can ask a different question.

Systolic blood pressure is when heart contracts to pump blood to the body from the heart.

What is diastolic blood pressure?
(Wade, C. (1975); Childre, D. L., & Wilson, B. (2006); Galton, L. (1973); Kaplan, N. M., & Lieberman, E. (1979))

Diastolic is the bottom number and it represents the minimum pressure of blood in the arteries, or maximum relaxation, where the heart is relaxing between beats.

If you prefer a simpler explanation, I can provide that. Or you can ask a different question.
Diastolic blood pressure is the blood pressure right before pumping more blood into the system.

Appendix E: Informative and Non-Technical Chatbot Answers

Introduction
Hello, my name is MedMind GPT. I'm here to help you learn about blood pressure today. You can ask questions about understanding blood pressure, learning how to manage or prevent it, who is affected, and more. What is your first question?

Generic
I am sorry, I am unable to answer that question. I am only trained to answer questions related to blood pressure topics. Do you have questions regarding blood pressure?

I am sorry, I am unable to answer that question. Do you have another question about blood pressure?

I am sorry but it does not appear that I have an answer for that. I will look into that in the future. Do you have another question about blood pressure?

I am only a chatbot and I don't know quite know what you are asking. Can you please ask your question in a different way?

I am only a chatbot and I don't know how to answer your question. Can you please ask your question in a different way?

Where can I find more information about high blood pressure?
The American Heart Association has more information on blood pressure if you wish to explore more later. I cannot currently send you there.

Risk
Why should I care? (https://www.webmd.com/hypertension-high-blood-pressure/5-misconceptions-about-hypertension; https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx)

High blood pressure is the largest single causative factor in all deaths. High blood pressure can lead to damage of your blood vessels, heart, kidneys, and other organs in your body. This results in the heart having to work harder to pump blood at a normal rate. Also, high blood pressure is a dangerous concern because of its effect on the walls of arteries. It increases atherosclerosis which causes the arteries to harden and reduces their flexibility. Over time, this hardening can have harmful effects. The effects include increased risk of stroke, heart attack, heart disease, and kidney failure.

What are the risk factors? (https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx)

High blood pressure is a dangerous concern because of its effects on the arteries. It increases atherosclerosis which causes the arteries to harden and reduces their flexibility. Over time, this hardening can have harmful effects. The effects include increased risk of stroke, heart attack, heart disease (3 times more likely), and kidney failure. Heart disease is the leading cause of death in the US. Stroke is the fifth leading cause.

What are comorbidities with high blood pressure?

When a person has high cholesterol, diabetes, or is overweight, they may also have high blood pressure. There are times too when a person with high blood pressure is later seen with other conditions. These conditions include growths in the uterus, gout, quadriplegia, menopause and a type of slow growing blood cancer. Research is still needed to learn about these connections.

Symptoms

What are symptoms? What are symptoms of high blood pressure?

High blood pressure is particularly dangerous as it is does not have distinct symptoms. Many of the symptoms of high blood pressure (e.g., headaches, dizziness, fatigue, nosebleeds) are just as common in people with normal blood pressure. People can have high blood pressure for years without knowing. One in three Americans with the condition are not aware of having it. This absence of symptoms gives it its name: the "silent" killer. Symptoms simply cannot be trusted as early warning signs of high blood pressure.

How can you tell if you have high blood pressure? How do I know if I have high blood pressure?

The best way to know if blood pressure is high is through regular doctor checkups. Many of the symptoms of high blood pressure (e.g., headaches, dizziness, fatigue, nosebleeds) are just as common in people with normal blood pressure. Symptoms simply cannot be trusted as early warning signs of high blood pressure.

Causes

What affects blood pressure? What causes high blood pressure?

The exact cause of high blood pressure is unknown. Several factors may play a role. These factors include age, race, family history, and weight. A few other possible factors include tobacco use, being physically inactive, stress, salt intake, alcohol use as well as some chronic illnesses.

- Age: The risk of high blood pressure increases as a person ages. The stress a person experiences in life may result in higher blood pressure levels. Age also decreases the

flexibility of the arteries. This is a problem as blood pressure is an interaction between the arteries and the heart.

- Race: High blood pressure is more common in people of African descent. It often develops at an earlier age than it does in whites. Serious problems such as stroke, heart attack and kidney failure are also more common for African Americans. The reason for these additional problems could be due to the increase risk of high blood pressure. The reason for the racial gap for increased risk of blood pressure and related issues is still unclear.
- Family history: High blood pressure can be genetic. In other words, it is passed down from parents or grandparents to kid. It tends to be in families who also have other hereditary diseases that include high blood pressure. One example of such a possible genetic disease is diabetes.
- Being overweight or obese: The more a person weighs the more blood they need to move through their body. Blood carries oxygen and other nutrient to tissues and important organs. As the volume of blood moving through the body and arteries increases so does the pressure on the arterial walls. This pressure on the walls causes damage. Being overweight also means the heart has to work harder to pump the increased blood amount through the larger body. This also increases the risk for high blood pressure as well as for heart disease and heart attacks.

Continue with more? (Y/N)

- Not being physically active: People who are not active usually have higher heart rates. These higher heart rates create strain on the heart to contract and relax more frequently. The higher a heart rate is, the harder the heart must work with each contraction. This causes a stronger force to be applied to the arteries. This greater force leads to damage in the arterial walls and a decrease in artery flexibility. Lack of physical activity also increases the risk of being overweight if not properly managed with diet. On a side note, it is important to know that blood pressure can increase temporarily right after a workout. In long-term health, working out helps lower blood pressure. It can also help to lose weight which is important for low blood pressure levels. Before starting any workout program, you should consult your doctor to make sure that it is safe to do so.
- Using tobacco: Smoking and chewing tobacco will immediately raise blood pressure temporarily. Over the long term, the chemicals in tobacco can damage the arterial walls. It also causes arteries to narrow or constrict. This increases the risk for heart disease. Also, secondhand smoke can also increase the risk of heart disease. Heart disease is the leading cause of death in the US.
- Too much salt in your diet: Too much salt intake can narrow small arteries by causing arterioles to swell. This results in more pressure being applied to the artery walls. This is part of what causes high blood pressure. Also, too much salt in a diet causes

the body to retain fluids. Keeping fluids means there is a greater volume of blood in the body. This larger volume of blood further raises blood pressure and puts strain on the heart.

- Too little potassium in your diet: Potassium helps balance the amount of salt in your cells. Salt cause the arteries to narrow and fluid to be keep in the body. If you do not get enough potassium in your diet or retain enough potassium, you may store too much salt in your blood.

- **Continue generating? (Y/N)**

- Drinking too much alcohol: Drinking more than the moderate amounts of alcohol can raise blood pressure by a several points. Over time, heavy drinking can damage the heart. On the other hand, drinking alcohol in moderation can actually lower blood pressure by a few points. Generally, one drink a day for women and two a day for men is the suggested amount. One drink is 12 ounces of beer, five ounces of wine, or 1.5 ounces of liquor.
- Stress: Chronic stress and even temporary stress can contribution to high blood pressure. Temporary high levels of stress can lead to a temporary increase in blood pressure. Over the long-term, this increase in blood pressure damages arterial walls. Also, when a person feels stressed, the body releases a hormone known as cortisol. Cortisol constricts artery passageways and interacts with the kidney to keep fluid. Both of these problems can increase blood pressure. Stress can also cause people to try to relax by eating more, using tobacco, or drinking alcohol. All of these can also increase problems with high blood pressure.
- Certain chronic conditions: Some chronic conditions may increase the risk of high blood pressure. These conditions include kidney disease, diabetes, chronic stress, and sleep apnea. Some of the conditions may be genetic. Therefore, managing high blood pressure may need different methods depending on how a person develops it. If you believe you have high blood pressure from a chronic condition, talk to your doctor.

Facts

How many people suffer from high blood pressure?

Around 1 out of 3 American adults have high blood pressure. This is about 75 million affected adults.

What ethnic group is most likely to experience high blood pressure?

The ethnic group most likely to have high blood pressure is African Americans. They have an increased risk of having high blood pressure and having complications (like heart attacks or strokes). The reasons for the racial difference of high blood pressure and related issues are unclear.

How likely is it for someone to have high blood pressure? Chances of developing high blood pressure? How many people develop high blood pressure in their lifetime?

High blood pressure generally develops in a lifetime. In fact, people have about a 90% chance of developing high blood pressure in their life.

Are there over the counter medicines for treating high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

In terms of handling high blood pressure, there are no over-the-counter (OTC) drugs that can replace medications and lifestyle changes. Before taking any OTC medicine that says it lowers blood pressure, talk to a doctor. The OTC pills may not work as it states. They may actually interfere with other pills. In fact, some OTC pills can even raise blood pressure.

Does over the counter medicine effect blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)
Always read the labels on all over-the-counter (OTC) medicines, especially if you have high blood pressure. If you have high blood pressure, and are on a prescribed pill, consult your doctor before taking any OTC drugs. The use of decongestants in OTC pills may raise blood pressure. They can also interfere with prescribed blood pressure medications.

Will Omega-3 affect my blood pressure? (https://www.verywellhealth.com/fish-oil-for-better-blood-pressure-89331)
There is some dispute on omega-3's effect on blood pressure. Some research believes that it may help control blood pressure. Other research has not found a correlation.

Something that may affect blood pressure is over-the-counter (OTC) medicine. OTC drugs may actually raise blood pressure. This is particularly true for decongestants. Decongestants can even interfere with prescribed blood pressure medications. If a person has high blood pressure, OTC medicine should be taken with caution.

Prevention

How do I find my own blood pressure? (medicalnewstoday.com/articles/321429.php#checking-pressure-manually)

Blood pressure it usually measured with a pressure cuff and stethoscope. Using these two tools, a person can measure the systolic and diastolic pressure. Systolic represents the maximum pressure in the blood vessels as the heart contracts. Diastolic represents the minimum pressure of blood in the arteries. This is when the heart is relaxing between beats. The numbers from these two readings create the blood pressure reading. The numbers are read as the systolic on the top and the diastolic on the bottom.

How often do you want to get your blood pressure measured? (https://www.webmd.com/hypertension-high-blood-pressure/qa/how-often-should-i-get-my-blood-pressure-checked)

The recommended number of blood pressure measurements may depend on a few factors. These factors include age, health conditions, and other potential blood pressure causes. Normally, blood pressure should be checked when you visit the doctor. The following general guidelines can give an idea for how often to check if you are still unsure:

On average, for a normal blood pressure you should check it at least every 2 years. This may be more frequently if your doctor recommends it. Normal blood pressure values are less than 120/80 mm Hg. If blood pressure is borderline high (called prehypertensive), you should check it at least every year. This can be more often at your doctor's recommendations. Borderline high values are between 120 mm Hg and 139 mm Hg over 80 mm Hg to 89 mm Hg. If blood pressure is 140/90 mm Hg or higher, you have high blood pressure and should see a doctor. You may need to start medication or lifestyle changes.

Is there a cure for high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure)
There is no "cure" for high blood pressure. Using medications as prescribed and making lifestyle changes can help. These changes can improve quality of life, reduce blood pressure levels, and reduce the risk of heart disease, stroke, and kidney disease.

What are ways to manage high blood pressure? What should I do if I am not safe? What are the treatment options for high blood pressure?

To manage high blood pressure, there are some lifestyle changes that can be made. These changes help reduce the chances of getting high blood pressure. Reducing high blood pressure can also reduce its other possible health problems (like heart attack or stroke). If you already have high blood pressure and lifestyle changes do not work, you may have to take medication. This medication is taken on a lifelong basis. Talk to your doctor either way before implementing any changes.

To manage or prevent high blood pressure, it is recommended to exercise regularly, lose weight, eat a healthy diet, use less salt, quit smoking (if relevant), limit alcohol and caffeine use, and reduce stress. In serious cases, it may be required to take medication. These methods should help stop blood pressure from rising and are good practices for other health benefits.

What can I do to prevent? What can I do to avoid getting high blood pressure?

To prevent high blood pressure, there are some lifestyle changes that can be made. These changes help reduce the chances of getting high blood pressure. Reducing high blood pressure can also reduce its other possible health problems (like heart attack or stroke). The ways to prevent high blood pressure are also very common for managing it if a person already has it. Talk to your doctor either way before implementing any changes.

To manage or prevent high blood pressure, it is recommended to work out regularly, lose weight, eat a healthy diet, eat less salt, quit smoking (if relevant), limit alcohol and caffeine use, and reduce stress. In serious cases, it may be required to take medication. These methods should help stop blood pressure from rising and are good practices for other health benefits.

- Lose weight: Blood pressure often increases as weight increases. Increased weight causes blood pressure to rise because more blood is needed to be pumped through a larger body. The pressure on the arterial walls increases as the volume of blood in the arteries increases. This results in damage to the arteries. Being overweight can also create sleep apnea. Sleep apnea is a condition that increases blood pressure. Losing weight is one of the best lifestyle changes for controlling blood pressure levels.

- Eat healthy: Eating a healthy diet can lower blood pressure. A healthy diet for blood pressure includes a lot of whole grains, fruits, vegetables, and low-fat dairy products. This diet has little saturated fats and cholesterol. This is usually if a person already has high blood pressure. It can help people though to eat healthier in general and prevent them from developing high blood pressure.

Continue generating? (Y/N)

- Exercise regularly: Regular physical activity can help lower blood pressure. Regular exercise is about 150 minutes a week or five days a week with 30-minute exercises. It is important to be regular with working out. Blood pressure can rise again if a person stops. If a person has elevated blood pressure, working out can help prevent them from developing high blood pressure. If a person already has high blood pressure, working out can bring blood pressure down to safer levels.

It is important to note, blood pressure can increase briefly right after a workout. In the long-term, working out can lower blood pressure levels as well as overall weight. Before starting any working program, you should talk to your doctor to make sure it is safe to do so.

What kind of exercise is good with high blood pressure? (HeartMath book)
Aerobic exercise is the best exercise for people who have high blood pressure. It can also help lower blood pressure in general. Examples of aerobic exercise include walking, swimming, and biking. Isometric exercise is usually not the best. This type of exercise includes heavy lifting. Lighter weights with more repetition should be fine. That may even help with flexibility. Consult your doctor for work out recommendations.

What foods should I avoid if I have high blood pressure?

- Eat less salt: Eating less salt can reduce blood pressure and improve heart health. The effect of salt intake on blood pressure changes between groups of people. Try to limit intake to about 2300 mg a day or less. As a person ages, a lower salt intake of around 1500 mg a day is even better. Too much salt can narrow the arteries and has the body retain fluids. Both of these can result in increasing blood pressure.
- Limit amount of alcohol: Drinking alcohol in moderation can potentially lower blood pressure. Generally, one drink a day for women and two a day for men is suggested amount. One drink is 12 ounces of beer, five ounces of wine, or 1.5 ounces of liquor. Drinking more than the moderate amounts of alcohol can raise blood pressure levels. Heavy drinking can even damage the heart.
- Quit smoking and/or tobacco use: Smoking increases blood pressure right after a person finishes. The chemicals in the tobacco can also damage the lining of the artery walls. This can cause arteries to narrow. Smoking, as well as secondhand smoking, can increase the risk of heart disease. Heart disease is the leading cause of death in the US. Blood pressure can return to normal levels if a person stops smoking or using tobacco products.

Continue generating? (Y/N)

- Cut back on caffeine: The effects of caffeine on blood pressure are still discussed. Caffeine can raise blood pressure a small amount in people who rarely consume it. For people who drink coffee regularly, they may experience little or no effect on their blood pressure. As for the long-term effects of caffeine on blood pressure,

that is still unknown. It is possible blood pressure may slightly increase over time with caffeine use.

- Reduce stress: Chronic stress or even just stressful events may lead to high blood pressure. Temporarily high levels of stress can cause temporary increases in blood pressure. These increases in blood pressure can damage the arterial walls. This damage can cause high blood pressure. Some recommended ways to reduce stress include taking more breaks, meditating, or attending a yoga class. Occasional stress can also lead to high blood pressure if a person reacts to stress by eating unhealthy foods, drinking alcohol, or smoking.

What things besides diet and exercises affect blood pressure?

Eating healthy food and working out can reduce blood pressure levels. Other factors that may reduce blood pressure include:

- Eat less salt
- Quit smoking
- Limit alcohol
- Limit coffee and soda
- Reduce stress

Are eggs healthy for me to take if I had blood pressure problems? (Diet book)
Eating a healthy diet can lower blood pressure. A healthy diet for blood pressure includes a lot of whole grains, fruits, vegetables, and low-fat dairy products. This diet has little saturated fats and cholesterol. Also, losing weight can help manage high blood pressure. One possible way to lose weight would be to add protein into a diet. Some possible proteins to add are eggs, chicken, and fish. Protein can help a person feel full throughout the day. Ideally, they could help a person reduce their total amount of food intake. The biggest food concern with high blood pressure is food rich in salt and fat.

Understanding
What is blood pressure?

Blood pressure is a way of measuring how much force is being applied to the walls of your blood vessels (artery) as blood flows through them. It is a part of the circulatory system in your body. When the heart contracts, it pushes the blood into the arteries. The arteries resist the pressure. Blood is then squeezed into smaller vessels of the body. Therefore, blood pressure is the combined amount of pressure in the blood, resistance of the arterial wall, and the closing of the heart valve. Overall, blood pressure is maintained by the contraction and relaxation of the blood vessels (contraction is the systolic pressure and relaxation is the diastolic pressure).

What is a healthy blood pressure?

Normal blood pressure is a reading with values less than 120/80 mm Hg. This is generally the same for most people. Since no two people are exactly alike, there is some range for what could be considered normal for healthy individuals.

Can blood pressure vary?

It is important to know blood pressure varies at different times throughout the day. This is quite normal. It can increase briefly during physical activity or decrease during sleep.

Is the recommended blood pressure appropriate for everybody?

Good blood pressure levels are mostly the same for everyone. The normal values are lower than 120/80 mm Hg. This is read as '120 over 80'. There have been some disagreements in recent health information. The discussion focuses on the idea that normal ranges may be different based on age. It has been suggested that the recommend blood pressure values are different for older people. (As people age, the stress they experience in their life may be a reason to recommend lower blood pressure levels).

High Blood Pressure

What is a high blood pressure?

There are four stages of high blood pressure. The stages are elevated blood pressure, hypertension stage 1, hypertension stage 2, and hypertension crisis. The most common type of high blood pressure is known as essential hypertension. It consists of the four stages of blood pressure stated before. It is the condition for 90-95% of the people who have high blood pressure. The four stages are:

1. Elevated blood pressure
    - Elevated blood pressure is when readings are about 120-129 over less than 80. The top number is the pressure when the heart is contracting. That is systolic pressure. The bottom is when the heart is relaxing between heart beats. That is diastolic pressure. People with elevated blood pressure are likely to develop high blood pressure unless lifestyle changes are made.

2. Hypertension Stage 1
    - Hypertension Stage 1 is when blood pressure is from 130-139 over 80-89. The top number is the pressure when the heart is contracting. The bottom is when the heart is relaxing between heart beats. At this stage of high blood pressure, doctors will suggest lifestyle changes. They may also suggest blood pressure medicine based on your risk of heart disease, heart attack, and stroke.

3. Hypertension Stage 2

- Hypertension Stage 2 is when blood pressure is around 140/90 or higher. At this stage of hypertension, doctors will suggest a blend of medicine and lifestyle changes. These changes decrease the risk of stroke, heart attack, heart disease, and kidney failure.

Continue generating? (Y/N)

4. Hypertensive crisis
    - This stage of high blood pressure requires medical attention. If blood pressure readings suddenly exceed 180/120, wait five minutes and test your blood pressure again. If your readings are still high call your doctor or 911. If symptoms such as chest pain, hard time breathing, numbness, a change in vision, or hard time speaking, are occurring with the high reading, call 911 right away.

Is high blood pressure worse than low pressure?

Generally, high blood pressure is more worrisome than low blood pressure. This is because problems from high blood pressure can lead to lasting damage to the body. The damage comes from health problems like strokes, heart attacks, heart disease, or kidney failure. Low blood pressure is a concern too though. It can cause dizziness and fainting which could result in serious injury from falling. Conditions depend on the symptoms and the person. Factors such as age, race, and gender play a role too.

When do men start to see an increase in blood pressure? Are men more likely to have high blood pressure than women?

Men and women may see an increase in blood pressure levels around the age of 40. It is important to note that high blood pressure can start at an earlier age though. If a person has a chronic disease like sleep apnea or diabetes, their chances of having high blood pressure increases. Until about age 64, high blood pressure is more common in men. This changes around 65 when high blood pressure is more common in women.

When do women start to see an increase in blood pressure?

Women and men may see an increase in blood pressure levels around the age of 40. High blood pressure can start at an earlier age. This is more common among men though. If a person has a chronic disease like sleep apnea or diabetes, their chances of having high blood pressure increases. Until about age 64, high blood pressure is more common in men. This changes around 65 when high blood pressure is more common in women. African American women aged 65 have the highest rate of high blood pressure.

How many women/men between the ages of 35-44 have high blood pressure? Can young people have high blood pressure? (https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

High blood pressure begins to rise around the age of 40 for most people (men and women). It is important to note that high blood pressure can start at an earlier age though. If a person has a chronic disease like sleep apnea or diabetes their chances of having high blood pressure increases.

By the age of 35 to the age of 44, about 20% of women will have high blood pressure. About 25% of men between the ages of 35-44 will have high blood pressure.

What is high blood pressure called?

High blood pressure is called hypertension. Low blood pressure is called hypotension.

Low Blood Pressure

Is there such a thing as low blood pressure? What is low blood pressure? Is it possible to have low blood pressure (i.e., hypotension)? If so, what would be considered a low blood pressure reading? (https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1)

Low blood pressure is a blood pressure reading of less than 90/60. Severely low blood pressure can be a sign of an underlying problem, particularly in the elderly. It may cause low blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs.

What is bad about low blood pressure? (https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1, https://www.healthline.com/health/hypotension#types)

In healthy individuals, low blood pressure without any symptoms is not usually a concern. Low blood pressure with symptoms can be a concern as it can cause dizziness, weakness, fainting and a risk of injury from falls. Severely low blood pressure can be a sign of an underlying problem, particularly in the elderly. It may cause low blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs.

What are symptoms of low blood pressure?

Low blood pressure symptoms include dizziness, fainting, blurred vision, fatigue, or lack of concentration. Severely low blood pressure may cause insufficient blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs. These conditions are especially concerning for elderly people.

Systolic/Diastolic

What are the two types of blood pressure?
What number is high/low? What is the difference between systolic and diastolic?
What does the top/bottom number mean?

Systolic is the top number; it represents the maximum pressure in the blood vessels as the heart contracts. The heart contracts to pump blood to the body from the heart. Diastolic is the bottom number; it represents the minimum pressure of blood in the arteries, or maximum relaxation. This is when the heart is relaxing between beats.

What is more important — the Systolic or Diastolic reading?

Both readings are important. The systolic number measures your blood pressure during a heart contraction. The diastolic number measures blood pressure between heart contractions or when it is relaxing. The two readings together give a blood pressure reading. If either of them is higher than the recommended normal range (or if both are), they can indicate potential issues.

Are they independent?

Systolic and diastolic readings are not independent. They are opposite functions of the heart, contracting and relaxing. These two functions create the pressure in the arteries. Systolic is the top number; it represents the maximum pressure in the blood vessel as the heart contracts. The heart contracts to pump blood to the body from the heart. Diastolic is the bottom number; it represents the minimum pressure of blood in the arteries, or maximum relaxation. This is when the heart is relaxing between beats.

What is systolic blood pressure?

Systolic is the top number. It represents the maximum pressure in the arteries as your heart contracts. The heart contracts to pump blood to the body from the heart.

What is diastolic blood pressure?

Diastolic is the bottom number. It represents the minimum pressure of blood in the arteries, or maximum relaxation. This state is when the heart is relaxing between beats. In other words, diastolic is right before pumping more blood into the system.

Appendix F: Conversational and Non-Technical Chatbot Answers

Introduction

Hello, my name is MedMind GPT. I'm here to help you learn about blood pressure today. You can ask questions about understanding blood pressure, learning how to manage or prevent it, who is affected, and more. What is your first question?

Generic
I am sorry, I am unable to answer that question. I am only trained to answer questions related to blood pressure topics. Do you have questions regarding blood pressure?

I am sorry, I am unable to answer that question. Do you have another question about blood pressure?

I am sorry but it does not appear that I have an answer for that. I will look into that in the future. Do you have another question about blood pressure?

I am only a chatbot and I don't know quite know what you are asking. Can you please ask your question in a different way?

I am only a chatbot and I don't know how to answer your question. Can you please ask your question in a different way?

Where can I find more information about high blood pressure?
The American Heart Association has more information on blood pressure if you wish to explore more later. I cannot currently send you there.

Risk

Why should I care? (https://www.webmd.com/hypertension-high-blood-pressure/5-misconceptions-about-hypertension; https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx)

High blood pressure is the largest single causative factor in all deaths. High blood pressure can lead to damage of your blood vessels, heart, kidneys, and other organs in your body. This results in the heart having to work harder to pump blood at a normal rate.

Feel free to ask for more information about why high blood pressure is harmful, or you can ask another question if you prefer.

Also, high blood pressure is a dangerous concern because of its effect on the walls of arteries. It increases atherosclerosis which causes the arteries to harden and reduces their flexibility.

Over time, this hardening can have harmful effects. The effects include increased risk of stroke, heart attack, heart disease, and kidney failure.

What are the risk factors? (https://www.sentara.com/healthwellness/data/blogs/5-reasons-it-is-important-to-manage-your-high-blood-pressure.aspx)

High blood pressure is a dangerous concern because of its effects on the arteries. It increases atherosclerosis which causes the arteries to harden and reduces their flexibility.

I can tell you why this is bad for your health over time if you'd like, or you can ask a different question.

Over time, this hardening can have harmful effects. The effects include increased risk of stroke, heart attack, heart disease (3 times more likely), and kidney failure. Heart disease is the leading cause of death in the US. Stroke is the fifth leading cause.

What are comorbidities with high blood pressure?

When a person has high cholesterol, diabetes, or is overweight, they may also have high blood pressure.

Please let me know if you want to learn more about other health problems that often come with high blood pressure, or if you'd rather ask a different question.

There are times too when a person with high blood pressure is later seen with other conditions. These conditions include growths in the uterus, gout, quadriplegia, menopause and a type of slow growing blood cancer. Research is still needed to learn about these connections.

Symptoms
What are symptoms? What are symptoms of high blood pressure?

High blood pressure is particularly dangerous as it is does not have distinct symptoms. Many people can have it for years without knowing.

If you're interested to learn more, you can pick from these facts:
- The number of Americans who have high blood pressure without knowing it.
- The nickname doctors use for hypertension.
- Why it's hard to spot hypertension through symptoms.

But if you'd rather change topics, feel free to ask a different question.

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

Fact 1: One out of every three Americans with high blood pressure doesn't even know they have it.

Fact 2: They call it the "silent" killer because it doesn't show many symptoms.

Fact 3: The problem is that the symptoms of high blood pressure, like headaches or dizziness, are also common in people with normal blood pressure. So, you can't rely on these signs to know if you have high blood pressure.

Thank you for your interest for learning about high blood pressure. If you'd like to keep learning more, you can pick from these facts:

- The number of Americans who have high blood pressure without knowing it.
- The nickname doctors use for hypertension.
- Why it's hard to spot hypertension through symptoms.

But if you'd rather change topics, feel free to ask a different question.

How can you tell if you have high blood pressure? How do I know if I have high blood pressure?

The best way to know if blood pressure is high is through regular doctor checkups.

I can tell you more about why it's hard to diagnose high blood pressure on your own. Or, if you prefer, you can go ahead and ask your next question.

Many of the symptoms of high blood pressure (e.g., headaches, dizziness, fatigue, nosebleeds) are just as common in people with normal blood pressure. Symptoms simply cannot be trusted as early warning signs of high blood pressure. That is why it is best to go to regularly see your doctor.

Causes

What affects blood pressure? What causes high blood pressure?

The exact cause of high blood pressure is unknown. Several factors may play a role. These factors include age, race, family history, and weight. A few other possible factors include tobacco use, being physically inactive, stress, salt intake, alcohol use as well as some chronic illnesses.

Choose from the following factors associated with hypertension to discuss further in depth:

- Age
- Race
- Family history
- Weight
- Tobacco consumption
- Being physically inactive
- Sodium consumption
- Potassium consumption
- Alcohol consumption
- Stress
- Certain chronic conditions

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the **conversational question]**

Based on what they choose:

- Age: The risk of high blood pressure increases as a person ages. The stress a person experiences in life may result in higher blood pressure levels. Age also decreases the flexibility of the arteries. This is a problem as blood pressure is an interaction between the arteries and the heart.
- Race: High blood pressure is more common in people of African descent. It often develops at an earlier age than it does in whites. Serious problems such as stroke, heart attack and kidney failure are also more common for African Americans. The reason for these additional problems could be due to the increase risk of high blood pressure. The reason for the racial gap for increased risk of blood pressure and related issues is still unclear.
- Family history: High blood pressure can be genetic. In other words, it is passed down from parents or grandparents to kid. It tends to be in families who also have other hereditary diseases that include high blood pressure. One example of such a possible genetic disease is diabetes.
- Being overweight or obese: The more a person weighs the more blood they need to move through their body. Blood carries oxygen and other nutrient to tissues and important organs. As the volume of blood moving through the body and arteries

increases so does the pressure on the arterial walls. This pressure on the walls causes damage. Being overweight also means the heart has to work harder to pump the increased blood amount through the larger body. This also increases the risk for high blood pressure as well as for heart disease and heart attacks.

- Not being physically active: People who are not active usually have higher heart rates. These higher heart rates create strain on the heart to contract and relax more frequently. The higher a heart rate is, the harder the heart must work with each contraction. This causes a stronger force to be applied to the arteries. This greater force leads to damage in the arterial walls and a decrease in artery flexibility. Lack of physical activity also increases the risk of being overweight if not properly managed with diet. On a side note, it is important to know that blood pressure can increase temporarily right after a workout. In long-term health, working out helps lower blood pressure. It can also help to lose weight which is important for low blood pressure levels. Before starting any workout program, you should consult your doctor to make sure that it is safe to do so.
- Using tobacco: Smoking and chewing tobacco will immediately raise blood pressure temporarily. Over the long term, the chemicals in tobacco can damage the arterial walls. It also causes arteries to narrow or constrict. This increases the risk for heart disease. Also, secondhand smoke can also increase the risk of heart disease. Heart disease is the leading cause of death in the US.
- Too much salt in your diet: Too much salt intake can narrow small arteries by causing arterioles to swell. This results in more pressure being applied to the artery walls. This is part of what causes high blood pressure. Also, too much salt in a diet causes the body to retain fluids. Keeping fluids means there is a greater volume of blood in the body. This larger volume of blood further raises blood pressure and puts strain on the heart.
- Too little potassium in your diet: Potassium helps balance the amount of salt in your cells. Salt cause the arteries to narrow and fluid to be keep in the body. If you do not get enough potassium in your diet or retain enough potassium, you may store too much salt in your blood.
- Drinking too much alcohol: Drinking more than the moderate amounts of alcohol can raise blood pressure by a several points. Over time, heavy drinking can damage the heart. On the other hand, drinking alcohol in moderation can actually lower blood pressure by a few points. Generally, one drink a day for women and two a day for men is the suggested amount. One drink is 12 ounces of beer, five ounces of wine, or 1.5 ounces of liquor.
- Stress: Chronic stress and even temporary stress can contribution to high blood pressure. Temporary high levels of stress can lead to a temporary increase in blood pressure. Over the long-term, this increase in blood pressure damages arterial walls. Also, when a person feels stressed, the body releases a hormone

known as cortisol. Cortisol constricts artery passageways and interacts with the kidney to keep fluid. Both of these problems can increase blood pressure. Stress can also cause people to try to relax by eating more, using tobacco, or drinking alcohol. All of these can also increase problems with high blood pressure.

- Certain chronic conditions: Some chronic conditions may increase the risk of high blood pressure. These conditions include kidney disease, diabetes, chronic stress, and sleep apnea. Some of the conditions may be genetic. Therefore, managing high blood pressure may need different methods depending on how a person develops it. If you believe you have high blood pressure from a chronic condition, talk to your doctor.

If you want to continue our conversation discussing factors related to high blood pressure, choose from the following:

- Age
- Race
- Family history
- Weight
- Tobacco consumption
- Being physically inactive
- Sodium consumption
- Potassium consumption
- Alcohol consumption
- Stress
- Certain chronic conditions

Facts

How many people suffer from high blood pressure?

Around 1 out of 3 American adults have high blood pressure. This is about 75 million affected adults.

What ethnic group is most likely to experience high blood pressure?

The ethnic group most likely to have high blood pressure is African Americans. They have an increased risk of having high blood pressure and having complications (like heart

attacks or strokes). The reasons for the racial difference of high blood pressure and related issues are unclear.

How likely is it for someone to have high blood pressure? Chances of developing high blood pressure? How many people develop high blood pressure in their lifetime?

High blood pressure generally develops in a lifetime. In fact, people have about a 90% chance of developing high blood pressure in their life.

Are there over the counter medicines for treating high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)

In terms of handling high blood pressure, there are no over-the-counter (OTC) drugs that can replace medications and lifestyle changes. Before taking any OTC medicine that says it lowers blood pressure, talk to a doctor.

If you'd like, I can tell you why it's important to be cautious with this medicine. Otherwise, feel free to ask another question about hypertension

The OTC pills may not work as it states. They may actually interfere with other pills. In fact, some OTC pills can even raise blood pressure.

Does over the counter medicine effect blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure/understanding-overthecounter-otc-medications-and-high-blood-pressure)
Always read the labels on all over-the-counter (OTC) medicines, especially if you have high blood pressure. If you have high blood pressure, and are on a prescribed pill, consult your doctor before taking any OTC drugs.

I can share an example of an over-the-counter medication that can influence blood pressure. If you'd like to explore a different topic, feel free to ask your next question.

It is recommended to take decongestant medication if you have high blood pressure. The use of decongestants in OTC pills may raise blood pressure. They can also interfere with prescribed blood pressure medications.
Will Omega-3 affect my blood pressure? (https://www.verywellhealth.com/fish-oil-for-better-blood-pressure-89331)
There is some dispute on omega-3's effect on blood pressure. Some research believes that it may help control blood pressure. Other research has not found a correlation.

I can share more details why it's important to limit the use of over-the-counter medicine, or if you're ready to move on, feel free to ask your next question.

Something that may affect blood pressure is over-the-counter (OTC) medicine. OTC drugs may actually raise blood pressure. This is particularly true for decongestants. Decongestants can even interfere with prescribed blood pressure medications. If a person has high blood pressure, OTC medicine should be taken with caution.

Prevention

How do I find my own blood pressure?
(medicalnewstoday.com/articles/321429.php#checking-pressure-manually)
(Childre, D. L., & Wilson, B. (2006); Wade, C. (1975))

Pick one of the following options to learn how to find your blood pressure:

- Tools to measure blood pressure
- Systolic blood pressure
- Diastolic blood pressure
- Generating a blood pressure reading

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

Tools to Measure Blood Pressure:
Blood pressure is checked using a sphygmomanometer and stethoscope. These tools help measure the heart's pumping force and artery pressure when you're relaxed.

Systolic Blood Pressure:
Systolic pressure is the higher number in a blood pressure reading. It shows the pressure in your arteries when your heart pumps blood during a heartbeat.

Diastolic Blood Pressure:
Diastolic pressure is the lower number in a blood pressure reading. It reflects the pressure in your arteries when your heart is at rest, just before the next beat.

Generating a Blood Pressure Reading:
Your blood pressure reading combines the two numbers. It's written as systolic over diastolic, like a fraction, and tells you about your overall blood pressure

If you want to learn more about how to find your blood pressure, pick from the following:

- Instruments to measure blood pressure
- Systolic blood pressure
- Diastolic blood pressure
- Generating a blood pressure reading

If you want to move on, please ask a different question.

Is there a cure for high blood pressure? (https://www.heart.org/en/health-topics/high-blood-pressure/changes-you-can-make-to-manage-high-blood-pressure)
There is no "cure" for high blood pressure. Using medications as prescribed and making lifestyle changes can help. These changes can improve quality of life, reduce blood pressure levels, and reduce the risk of heart disease, stroke, and kidney disease.

What are ways to manage high blood pressure? What should I do if I am not safe? What are the treatment options for high blood pressure?

To manage high blood pressure, there are some lifestyle changes that can be made. These changes help reduce the chances of getting high blood pressure. Reducing high blood pressure can also reduce its other possible health problems (like heart attack or stroke). If you already have high blood pressure and lifestyle changes do not work, you may have to take medication. This medication is taken on a lifelong basis. Talk to your doctor either way before implementing any changes.

If you'd like more information on how to control and avoid hypertension, just let me know. If not, feel free to ask your next question.

To manage or prevent high blood pressure, it is recommended to exercise regularly, lose weight, eat a healthy diet, use less salt, quit smoking (if relevant), limit alcohol and caffeine use, and reduce stress. In serious cases, it may be required to take medication. These methods should help stop blood pressure from rising and are good practices for other health benefits.

How often do you want to get your blood pressure measured?
(https://www.webmd.com/hypertension-high-blood-pressure/qa/how-often-should-i-get-my-blood-pressure-checked)

The recommended number of blood pressure measurements may depend on a few factors. These factors include age, health conditions, and other potential blood pressure causes. Normally, blood pressure should be checked when you visit the doctor.

To know more about the general suggestions for how often you need to go to the doctor to get checked for blood pressure, choose from the following:

- Less than 120/80 mm Hg

- Diastolic blood pressure is between 80 mm Hg to 89 mm Hg
- Systolic blood pressure is between 120 mm Hg and 139 mm Hg
- Higher or equal to 140/90 mm Hg

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

- If your blood pressure is less than 120/80 mm Hg, (considered normal blood pressure), get it checked at least every 2 years or more at your doctor's recommendation.

- If your diastolic blood pressure is between 80 mm Hg to 89 mm Hg, check it at least every year or more often at your doctor's recommendation.

- If your systolic blood pressure is between 120 mm Hg and 139 mm Hg, check it at least every year or more often at your doctor's recommendation.

- If your reading is 140/90 mm Hg or higher, you have high blood pressure and need to see your doctor. You may need to start taking medicine or change lifestyle habits.

If you want to continue to know more about the general guidelines based on the average frequencies you need to your doctor for various blood pressure readings, choose from the following:

- Less than 120/80 mm Hg
- Diastolic blood pressure is between 80 mm Hg to 89 mm Hg
- Systolic blood pressure is between 120 mm Hg and 139 mm Hg
- Higher or equal to 140/90 mm Hg

What can I do to prevent? What can I do to avoid getting high blood pressure?

To prevent high blood pressure, there are some lifestyle changes that can be made. These changes help reduce the chances of getting high blood pressure. Reducing high blood pressure can also reduce its other possible health problems (like heart attack or stroke). The ways to prevent high blood pressure are also very common for managing it if a person already has it. Talk to your doctor either way before implementing any changes.

To manage or prevent high blood pressure, choose from the following topics to learn more about preventing high blood pressure:

- Losing weight
- Eating healthy
- Exercising regularly
- Reducing Stress
- Quit smoking and/or tobacco use

Based on what they choose:

- Lose weight: Blood pressure often increases as weight increases. Increased weight causes blood pressure to rise because more blood is needed to be pumped through a larger body. The pressure on the arterial walls increases as the volume of blood in the arteries increases. This results in damage to the arteries. Being overweight can also create sleep apnea. Sleep apnea is a condition that increases blood pressure. Losing weight is one of the best lifestyle changes for controlling blood pressure levels.

- Eat healthy: Eating a healthy diet can lower blood pressure. A healthy diet for blood pressure includes a lot of whole grains, fruits, vegetables, and low-fat dairy products. This diet has little saturated fats and cholesterol. This is usually if a person already has high blood pressure. It can help people though to eat healthier in general and prevent them from developing high blood pressure.

- Exercise regularly: Regular physical activity can help lower blood pressure. Regular exercise is about 150 minutes a week or five days a week with 30-minute exercises. It is important to be regular with working out. Blood pressure can rise again if a person stops. If a person has elevated blood pressure, working out can help prevent them from developing high blood pressure. If a person already has high blood pressure, working out can bring blood pressure down to safer levels. It is important to note, blood pressure can increase briefly right after a workout. In the long-term, working out can lower blood pressure levels as well as overall weight. Before starting any working program, you should talk to your doctor to make sure it is safe to do so.

- Reduce stress: Chronic stress or even just stressful events may lead to high blood pressure. Temporarily high levels of stress can cause temporary increases in blood pressure. These increases in blood pressure can damage the arterial walls. This damage can cause high blood pressure. Some recommended ways to reduce stress include taking more breaks, meditating, or attending a yoga class. Occasional stress can also lead to high blood pressure if a person reacts to stress by eating unhealthy foods, drinking alcohol, or smoking.

- Quit smoking and/or tobacco use: Smoking increases blood pressure right after a person finishes. The chemicals in the tobacco can also damage the lining of the artery walls. This can cause arteries to narrow. Smoking, as well as secondhand smoking, can increase the risk of heart disease. Heart disease is the leading cause of death in the US. Blood pressure can return to normal levels if a person stops smoking or using tobacco products.

If you want to keep learning more about how to manage or prevent high blood pressure, choose from the following topics:

- Losing weight
- Eating healthy
- Exercising regularly
- Reducing Stress
- Quit smoking and/or tobacco use

What kind of exercise is good with high blood pressure? (HeartMath book)

Aerobic exercise is the best exercise for people who have high blood pressure. It can also help lower blood pressure in general. Examples of aerobic exercise include walking, swimming, and biking.

If you'd like to learn about exercises you should avoid, please ask. Otherwise, go ahead and ask your next question.

Isometric exercise is usually not the best. This type of exercise includes heavy lifting. Lighter weights with more repetition should be fine. That may even help with flexibility. Consult your doctor for work out recommendations.

What foods should I avoid if I have high blood pressure?

To avoid high blood pressure in your diet, it is best to consume less sodium, limit the amount of alcohol, and quit smoking and/or tobacco use.

To go more in depth in this topic, choose what you would like to know more about:

- Why you should consume less sodium in your diet.
- Why you should limit the amount of alcohol in your diet.
- Why you should quit smoking and/or tobacco use.
- Why you should cut back on caffeine intake

Based on what they choose:

- Eat less salt: Eating less salt can reduce blood pressure and improve heart health. The effect of salt intake on blood pressure changes between groups of people. Try to limit intake to about 2300 mg a day or less. As a person ages, a lower salt intake of around 1500 mg a day is even better. Too much salt can narrow the arteries and has the body retain fluids. Both of these can result in increasing blood pressure.
- Limit amount of alcohol: Drinking alcohol in moderation can potentially lower blood pressure. Generally, one drink a day for women and two a day for men is suggested amount. One drink is 12 ounces of beer, five ounces of wine, or 1.5 ounces of liquor. Drinking more than the moderate amounts of alcohol can raise blood pressure levels. Heavy drinking can even damage the heart.
- Quit smoking and/or tobacco use: Smoking increases blood pressure right after a person finishes. The chemicals in the tobacco can also damage the lining of the artery walls. This can cause arteries to narrow. Smoking, as well as secondhand smoking, can increase the risk of heart disease. Heart disease is the leading cause of death in the US. Blood pressure can return to normal levels if a person stops smoking or using tobacco products.
- Cut back on caffeine: The effects of caffeine on blood pressure are still discussed. Caffeine can raise blood pressure a small amount in people who rarely consume it. For people who drink coffee regularly, they may experience little or no effect on their blood pressure. As for the long-term effects of caffeine on blood pressure, that is still unknown. It is possible blood pressure may slightly increase over time with caffeine use.

To continue learning about this topic, choose what you would like to know more about:

- Why you should consume less sodium in your diet.
- Why you should limit the amount of alcohol in your diet.
- Why you should quit smoking and/or tobacco use.
- Why you should cut back on caffeine intake

What things besides diet and exercises affect blood pressure?

Eating healthy food and working out can reduce blood pressure levels. Other factors that may reduce blood pressure include:

- Eat less salt
- Quit smoking
- Limit alcohol
- Limit coffee and soda
- Reduce stress

Are eggs healthy for me to take if I had blood pressure problems? (Diet book)
Eating a healthy diet can lower blood pressure. A healthy diet for blood pressure includes a lot of whole grains, fruits, vegetables, and low-fat dairy products. This diet has little saturated fats and cholesterol. Also, losing weight can help manage high blood pressure. One possible way to lose weight would be to add protein into a diet. Some possible proteins to add are eggs, chicken, and fish. Protein can help a person feel full throughout the day. Ideally, they could help a person reduce their total amount of food intake.

I can sum up the main food worries related to hypertension, or if you're ready, you can go ahead and ask your next question.

The biggest food concern with high blood pressure is food rich in salt and fat.

Understanding
What is blood pressure?

Blood pressure is a way of measuring how much force is being applied to the walls of your blood vessels (artery) as blood flows through them. It is a part of the circulatory system in your body. When the heart contracts, it pushes the blood into the arteries. The arteries resist the pressure. Blood is then squeezed into smaller vessels of the body.

I can explain more about this topic if you'd like. If not, ask your next question please.

Due to this, blood pressure is the combined amount of pressure in the blood, resistance of the arterial wall, and the closing of the heart valve. Overall, blood pressure is maintained by the contraction and relaxation of the blood vessels (contraction is the systolic pressure and relaxation is the diastolic pressure).

What is a healthy blood pressure?

Normal blood pressure is a reading with values less than 120/80 mm Hg. This is generally the same for most people.

I can give more information if you'd like, or you can go ahead and ask your next question.

Since no two people are exactly alike, there is some range for what could be considered normal for healthy individuals.

Can blood pressure vary?

It is important to know blood pressure varies at different times throughout the day. This is quite normal. It can increase briefly during physical activity or decrease during sleep.

Is the recommended blood pressure appropriate for everybody?

Good blood pressure levels are mostly the same for everyone. The normal values are lower than 120/80 mm Hg. This is read as '120 over 80'.

Some recent health studies have different ideas about what's normal for blood pressure. If you want to learn more, just ask. If not, feel free to ask your next question.

There have been some disagreements in recent health information. The discussion focuses on the idea that normal ranges may be different based on age. It has been suggested that the recommend blood pressure values are different for older people. (As people age, the stress they experience in their life may be a reason to recommend lower blood pressure levels).

High Blood Pressure

What is a high blood pressure?

There are four stages of high blood pressure. The stages are elevated blood pressure, hypertension stage 1, hypertension stage 2, and hypertension crisis. The most common type of high blood pressure is known as essential hypertension. It consists of the four stages of blood pressure stated before. It is the condition for 90-95% of the people who have high blood pressure.

Pick from the following to learn more about the different stages of hypertension:

1. Elevated blood pressure
2. Hypertension Stage 1
3. Hypertension Stage 2
4. Hypertensive crisis

[After you copy and paste what they have chosen, go to the end of these bullet points to find a modified version of the conversational question]

Based on what they choose:

Elevated blood pressure

- Elevated blood pressure is when readings are about 120-129 over less than 80. The top number is the pressure when the heart is contracting. That is systolic pressure. The bottom is when the heart is relaxing between heart beats. That is diastolic pressure. People with elevated blood pressure are likely to develop high blood pressure unless lifestyle changes are made.

Hypertension Stage 1

- Hypertension Stage 1 is when blood pressure is from 130-139 over 80-89. The top number is the pressure when the heart is contracting. The bottom is when the heart is relaxing between heart beats. At this stage of high blood pressure, doctors will suggest lifestyle changes. They may also suggest blood pressure medicine based on your risk of heart disease, heart attack, and stroke.

Hypertension Stage 2

- Hypertension Stage 2 is when blood pressure is around 140/90 or higher. At this stage of hypertension, doctors will suggest a blend of medicine and lifestyle changes. These changes decrease the risk of stroke, heart attack, heart disease, and kidney failure.

Hypertensive crisis

- This stage of high blood pressure requires medical attention. If blood pressure readings suddenly exceed 180/120, wait five minutes and test your blood pressure again. If your readings are still high call your doctor or 911. If symptoms such as chest pain, hard time breathing, numbness, a change in vision, or hard time speaking, are occurring with the high reading, call 911 right away.

If you would like to continue learning about the different stages of high blood pressure, pick from the following:

1. Elevated blood pressure
2. Hypertension Stage 1
3. Hypertension Stage 2
4. Hypertensive crisis

Is high blood pressure worse than low pressure?

Generally, high blood pressure is more worrisome than low blood pressure. This is because problems from high blood pressure can lead to lasting damage to the body. The damage comes from health problems like strokes, heart attacks, heart disease, or kidney failure.

I can explain more about why low blood pressure can be risky, or if you'd like, you can ask a different question.

There are some differences when it comes to low blood pressure being a concern. In some individuals, it can cause dizziness and fainting which could result in serious injury from falling. But these conditions are dependent on the symptoms and the person. Factors such as age, race, and gender play a role too.

Are men more likely to have high blood pressure than women?
High blood pressure is often seen more in men until they're about 64 years old. But once they reach 65, it becomes more common in women.

When do men start to see an increase in blood pressure?
Men and women may see an increase in blood pressure levels around the age of 40. It is important to note that high blood pressure can start at an earlier age though. If a person has a chronic disease like sleep apnea or diabetes, their chances of having high blood pressure increases.

I can give more details about the differences in blood pressure rates between men and women, or if you prefer, you can ask another question.

Until about age 64, high blood pressure is more common in men. But after age 65, it becomes more prevalent in women.

When do women start to see an increase in blood pressure?

Women and men may see an increase in blood pressure levels around the age of 40. High blood pressure can start at an earlier age. This is more common among men though. If a person has a chronic disease like sleep apnea or diabetes, their chances of having high blood pressure increases.

I can explain more about how blood pressure rates vary between men and women, or if you'd prefer, you can ask a different question.

Until about age 64, high blood pressure is more common in men. This changes around 65 when high blood pressure is more common in women. African American women aged 65 have the highest rate of high blood pressure.

How many women/men between the ages of 35-44 have high blood pressure? Can young people have high blood pressure? (https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319587.pdf)

High blood pressure begins to rise around the age of 40 for most people (men and women). It is important to note that high blood pressure can start at an earlier age though. If a person has a chronic disease like sleep apnea or diabetes their chances of having high blood pressure increases.

I have some statistics on this topic if you're interested, but if you'd like to switch to another aspect of high blood pressure, feel free to ask.

By the age of 35 to the age of 44, about 20% of women will have high blood pressure. About 25% of men between the ages of 35-44 will have high blood pressure.

What is high blood pressure called?

High blood pressure is called hypertension. Low blood pressure is called hypotension.

Low Blood Pressure
Is there such a thing as low blood pressure? What is low blood pressure? Is it possible to have low blood pressure (i.e., hypotension)? If so, what would be considered a low blood pressure reading? (https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1)

Low blood pressure is a blood pressure reading of less than 90/60.

I can talk more about why low blood pressure is dangerous, but if you'd like to switch to a different topic, just ask.

Severely low blood pressure can be a sign of an underlying problem, particularly in the elderly. It may cause low blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs.

What is bad about low blood pressure? (https://www.webmd.com/heart/understanding-low-blood-pressure-basics#1, https://www.healthline.com/health/hypotension#types)

In healthy individuals, low blood pressure without any symptoms is not usually a concern. Low blood pressure with symptoms can be a concern as it can cause dizziness, weakness, fainting and a risk of injury from falls.

If you're curious about why low blood pressure might indicate an underlying issue, I can explain more. Or, if you have a different question in mind, feel free to ask.

Severely low blood pressure can be a sign of an underlying problem, particularly in the elderly. It may cause low blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs.

What are symptoms of low blood pressure?

Low blood pressure symptoms include dizziness, fainting, blurred vision, fatigue, or lack of concentration. Severely low blood pressure may cause insufficient blood flow. Low blood flow does not provide the body with enough oxygen to carry out its normal functions. This can result in damage to the heart, brain, and other important organs.

If you want, I can offer more information about who is affected by low blood pressure. However, if you'd like to explore a different question, please go ahead.

These conditions are especially concerning for elderly people.

Systolic/Diastolic
What are the two types of blood pressure?
What number is high/low? What is the difference between systolic and diastolic?
What does the top/bottom number mean?

Blood pressure has two parts: systolic (the top number) and diastolic (the bottom number).

I'm ready to give you a more detailed explanation of these two types of blood pressure. Please don't hesitate to ask if you'd like to learn more.

Systolic Pressure:
The top number, systolic pressure, tells us how hard our heart pushes when it pumps blood into our body. It's like a strong squeeze from our heart to get the blood moving.

Diastolic Pressure:
The bottom number, diastolic pressure, shows how relaxed our heart and arteries are when our heart takes a little break between beats. It's like a resting moment before the next squeeze to send more blood into our body.

What is more important — the Systolic or Diastolic reading?

Both readings are important. The systolic number measures your blood pressure during a heart contraction. The diastolic number measures blood pressure between heart contractions or when it is relaxing.

I can provide more detailed information, or you're welcome to ask any other questions you might have.

The two readings together give a blood pressure reading. If either of them is higher than the recommended normal range (or if both are), they can indicate potential issues.

Are they independent?

Systolic and diastolic readings are not independent. They are opposite functions of the heart, contracting and relaxing. These two functions create the pressure in the arteries.

If you'd like a more detailed explanation, I'm here to provide additional information. Alternatively, you can ask a different question if you prefer.

Systolic is the top number; it represents the maximum pressure in the blood vessel as the heart contracts. The heart contracts to pump blood to the body from the heart. Diastolic is the bottom number; it represents the minimum pressure of blood in the arteries, or maximum relaxation. This is when the heart is relaxing between beats.

What is systolic blood pressure?

Systolic is the top number. It represents the maximum pressure in the arteries as your heart contracts.

If you want a simpler explanation, just ask. Or you can ask something else.

Systolic blood pressure happens when the heart squeezes to push blood into the body.

What is diastolic blood pressure?

Diastolic is the bottom number. It represents the minimum pressure of blood in the arteries, or maximum relaxation. This state is when the heart is relaxing between beats.

If you want things explained in an easier way, I can do that. Otherwise, feel free to ask something else.

Diastolic blood pressure is the blood pressure when the heart is resting just before it pumps more blood into the body.

Appendix G: R Code for Bernoulli Hierarchical Bayesian Regression

```
model_code <- "
model
{
# Likelihood
for (i in 1:N) {
  y[i] ~ dbern(p[i])
  p[i] <- 1 / (1 + exp(-z[i]))
  z[i] <- (intercept + beta1*(communication_effect[i]) + beta2*(language_effect[i]) +
beta3*(usability[i]) + beta4*(usability[i]*language_effect[i]))

#Draw beta and intercept values from normal distributions
beta1 ~ dnorm(mu.beta1, tau.beta1)
beta2 ~ dnorm(mu.beta2, tau.beta2)
beta3 ~ dnorm(mu.beta3, tau.beta3)
beta4 ~ dnorm(mu.beta4, tau.beta4)
intercept ~ dnorm(mu.intercept, tau.intercept)

#Priors for betas (i.e., explanatory variables) and intercept
mu.beta1 ~ dnorm(0,0.00001)
mu.beta2 ~ dnorm(0,0.00001)
mu.beta3 ~ dnorm(0,0.00001)
mu.beta4 ~ dnorm(0,0.00001)
mu.intercept ~ dnorm(0,0.00001)

#Priors for standard deviation
sigma ~ dunif(0,10)
sigma.beta1 ~ dunif(0,10)
sigma.beta2 ~ dunif(0,10)
sigma.beta3 ~ dunif(0,10)
sigma.beta4 ~ dunif(0,10)
sigma.intercept ~ dunif(0,10)

#Derived quantities
tau.beta1 <- 1/(sigma.beta1*sigma.beta1)
tau.beta2 <- 1/(sigma.beta2*sigma.beta2)
tau.beta3 <- 1/(sigma.beta3*sigma.beta3)
tau.beta4 <- 1/(sigma.beta4*sigma.beta4)
tau.intercept <- 1/(sigma.intercept*sigma.intercept)

###NOTE: In JAGS a normal distribution is parametrized by its precision (1/variance).
Thus, dnorm(mean, precision)###
}"
```

Appendix H: Autocorrelation Plots for the Effectiveness Model

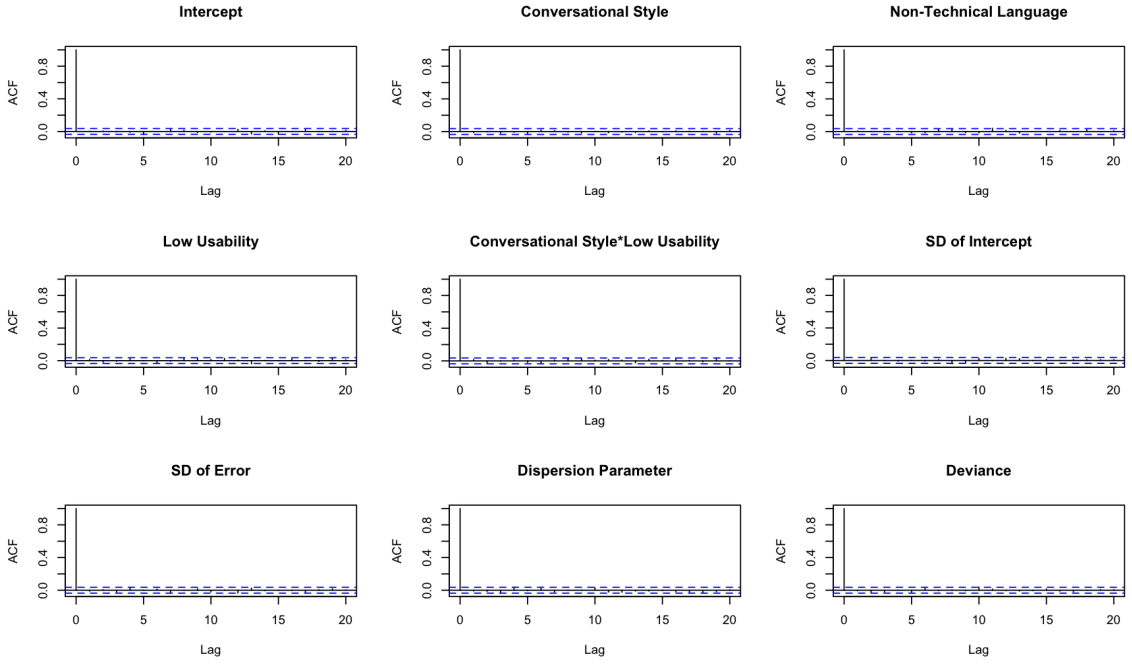


Figure H1. Autocorrelation Plots for the Parameters in the Effectiveness Model

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