Health data visualization designed for patients with hypertension

BACKGROUND

Hypertension is a leading cause of strokes in adults. Patients diagnosed with hypertension must regularly monitor physiological indicators such as heart rate and blood pressure.

Among other factors, **elevated blood pressure and heart rate can be triggered by stress or when we feel angry or anxious.** Therefore, identifying and understanding the long-term relationship between emotions, blood pressure, and heart rate is crucial in helping hypertension patients better manage their condition.

DESIGN TASKS

- Task 1: Identify the increased blood pressure, heart rate, and associated risks.
- Task 2: Users can recognize patterns in blood pressure, heart rate, and emotions over time.
- Task 3: Compare heart rate and blood pressure between two or more time points & across two or more emotions.

DESIGN PROCESS

Discover

Key data

Define

Design tasks
General design principles

Prototype

Visualization 1
Visualization 2

Test & Iterating

A/B Test
Data analysis
Redesign suggestions

TARGET USER

- **Population with Low Health Literacy**

Low health literacy refers to the limited ability of individuals to obtain, understand, and effectively use basic health information and services to make informed decisions for maintaining and improving their health.

- **Young People**

In recent years, the proportion of young and middle-aged individuals with hypertension has rapidly increased (Ondimu, Kikuvi & Otieno, 2019). Early detection and control of hypertension is a cost-effective way to reduce risks (Dzau & Balabat, 2019).

DESIGN PRINCIPLES

COLOUR

Colour Blindness: Use colours with different brightness levels or colour palettes that are friendly to colourblind individuals.
Consistency: Use the same colour for data with the same meaning to enhance the usability of the visualization (Kirk, 2019).

LAYOUT

Gestalt Principles
Enclosure: Helps users distinguish between different chart elements.
Similarity: Place related data close to each other, making it easier for users to identify connections.

KEY DATA & PRESENTATION

Blood pressure: systolic & diastolic

Type	Systolic	and/or	Diastolic	Color
Normal	<120		<80	Green
Elevated	120-129		<80	Yellow
Hypertension I	130-139		80-89	Orange
Hyper II	140 or higher		90 or higher	Red
Crisis	>180		>120	Deep Red

Designing based on pre-attentive factors (such as color) to help users with low health literacy identify abnormal health conditions (Barrera-Leon et al., 2022).

- Combining hypertension risk with traffic light colors reinforces the severity of elevated blood pressure.
- Choose colors with different brightness levels to accommodate colorblind individuals.

Heart rate

Bradycardia	Normal	Tachycardia
<60 bmp	60-100 bmp	>100 bmp
Blue	Green	Red

- Selected a colorblind-friendly color combination (Kirk, 2019).
- Colors were chosen based on color psychology: green indicates normal, blue represents too low, and red signifies too high.

Mood

Happy Relax Stressed Angry

Based on Nielsen's usability design principles, common emoji icons were selected.

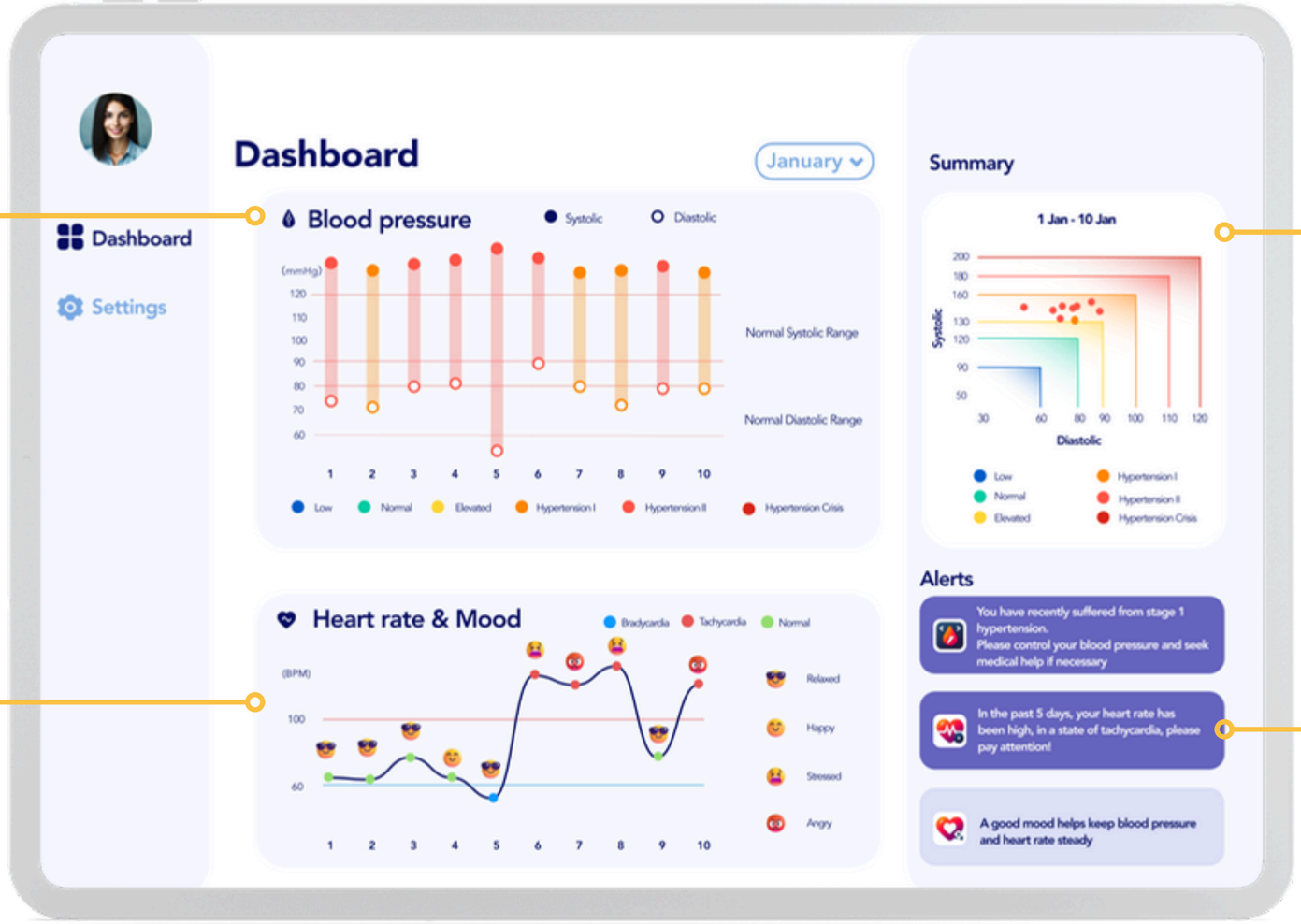
Visualisation 1

Blood pressure

- Chart: Bar graph - visually displays blood pressure levels and trends.
- Healthy Range Reference Line: A red dashed line indicates when blood pressure exceeds the normal range.
- Different Symbols: Different symbols are used to represent diastolic and systolic blood pressure.

Heart rate

- Chart: Line graph - visually presents the trend of continuous data over time.
- Emotion Display: Displays daily mood alongside blood pressure to help users understand how their emotions impact hypertension and heart rate.



Risk Summary

Scatter Plot: The X-axis represents DBP (diastolic blood pressure) and the Y-axis represents SBP (systolic blood pressure), with colors and ranges indicating different blood pressure risk levels, making it easier for users to get an overview of their health status.

Alert

Provide users with clear warnings and recommendations, and differentiate the importance of warnings through varying shades of color.

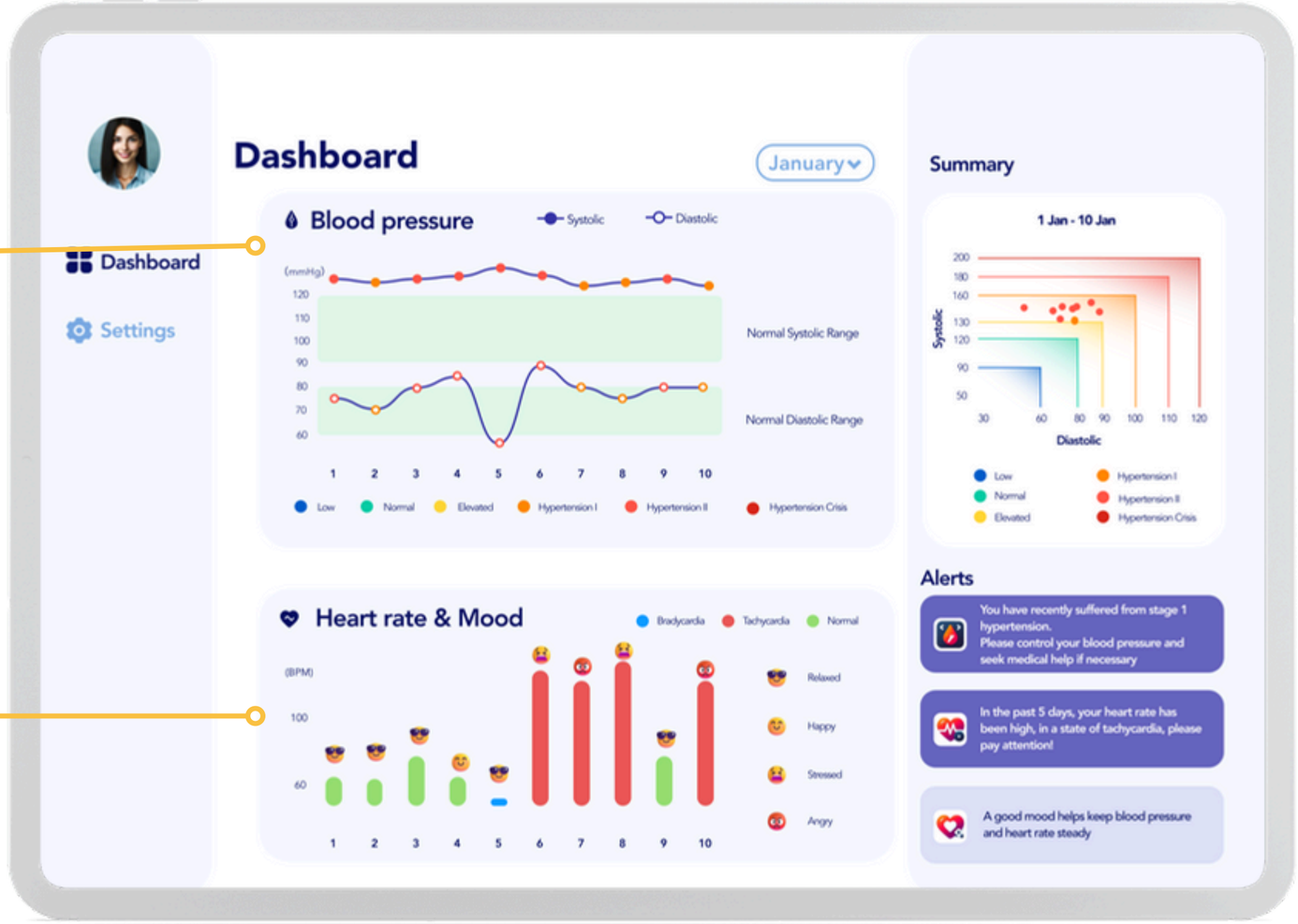
Visualisation 2

Blood pressure

- Chart: Line graph - shows the trend of blood pressure changes over time.
- Bullet Chart: Uses a green area to represent the normal blood pressure range.
- Different Symbols: Different symbols are used to represent diastolic and systolic blood pressure.

Heart rate

- Chart: Bar graph - simultaneously displays both trends and values.
- Emotion Display: Shows daily mood alongside blood pressure to help users understand how their emotions affect hypertension and heart rate.



A/B TEST

Methodology

1. **Method:** Distribute questionnaires for testing and conduct quantitative analysis. The collected data were analyzed for significance using SPSS.
2. **Questionnaire:** The questionnaire first tested participants' ability to interpret visual data, numeracy skills, and health literacy. Based on their scores, participants were classified with high and low visual interpretation abilities. Then, respondents viewed two different visualization designs and were asked to answer questions assessing four aspects: comprehension, risk prediction, perceived usefulness, and cognitive load.
3. **Sample:** 17 participants completed the questionnaire and answered all the questions.

Results

Perceived usefulness

Visualization 2 is significantly better than Visualization 1 in terms of perceived usefulness (p=0.26).

Cognitive load

Visualization 2 requires less mental effort.

Risk interpretation

Visualization 2 is slightly better than Visualization 1 in helping users with risk prediction, but the result is not significant .

Comprehension

Visualization 2 is more effective in helping users understand the presented content.

REDESIGN ADVICE

Reduce users' cognitive load by distinguishing elements through colour.

In Visualization 2, improve the presentation of the line graph. The current use of line colors to indicate risk might increase users' cognitive load. Instead, use different background colors within the reference range of the chart to represent risk, accompanied by text prompts. Additionally, separate diastolic and systolic blood pressure into two distinct charts.

Make the graphical language easier to understand.

Modify the presentation of the bar graph and add a trend line in Visualization 1. The current modified bar graph does not reduce users' cognitive load; instead, it makes it difficult for them to understand. In the improved design, systolic and diastolic blood pressure will be displayed in two separate bar graphs, and a trend line will be added to help users identify trends.

Improve risk perception.

In both visualizations, users cannot directly perceive the risks associated with hypertension from the graphics. The method of indicating risk in the charts needs improvement, such as using more noticeable colors or adding special symbols.