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Research Paper

Visualizing Blood Pressure Data and Identifying Abnormal Ranges Using the Equation of a Circle on a Coordinate Plane

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ABSTRACT
This study proposes an intuitive visual identification model for evaluating patients' blood pressure status by integrating the mathematical concept of the "Equation of a Circle" from High School Common Mathematics 2 with vital signs analysis in Basic Clinical Nursing Practice. In clinical environments, interpreting systolic and diastolic blood pressure solely through numerical tables can cause confusion and requires repetitive manual comparison against reference intervals. To overcome this limitation, systolic blood pressure was assigned to the x-axis and diastolic blood pressure to the y-axis on a Cartesian coordinate plane. Setting the standard normal blood pressure (120, 80) as the center of the circle and the clinically acceptable tolerance of 10 mmHg as the radius (r = 10), the normal blood pressure zone was mathematically defined by the equation $(x - 120)^2 + (y - 80)^2 = 100$. Three peer health checkup records measured on July 7, 2025 (Patients A, B, and C) and two simulated abnormal cases (hypertension and hypotension) were mapped onto the coordinate plane using the Desmos graphing calculator. The findings confirm that plotting blood pressure as coordinate pairs alongside a reference circle enables immediate visual assessment of whether an individual falls near the normal threshold or deviates into high-risk abnormal territories.

Keywords: *Equation of a Circle, Blood Pressure Visualization, Systolic and Diastolic Pressure, Basic Clinical Nursing Practice, Vital Signs Assessment*

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I. Introduction

1. Relevant Curriculum Unit and Research Motivation

During the first year of high school in the Common Mathematics 2 course, learning the "Equation of a Circle" within the Equations of Geometric Figures unit sparked significant curiosity about how a geometric circle can be represented on a coordinate plane using an algebraic formula. The coordinate plane was particularly appealing because it allows multiple numerical values to be grasped at a glance. Meanwhile, while studying Basic Clinical Nursing Practice in major coursework, a clear need emerged for a geometric visualization tool capable of displaying patients' vital signs at a glance. Realizing that the equation of a circle—which initially felt like mere formula memorization—could be directly applied to a future career in nursing served as the primary motivation for this research.

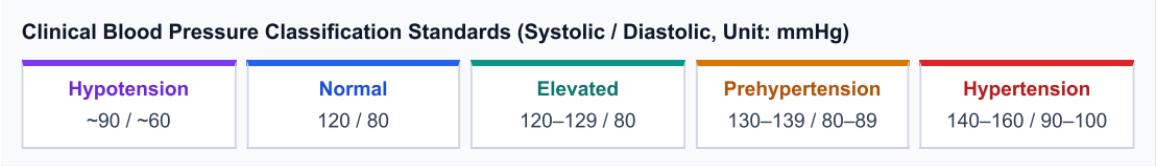
2. Research Background and Objectives

When examining patients' blood pressure readings solely as raw numbers, figures can occasionally be confused, and comparing each reading against standard reference intervals introduces practical inconvenience. However, representing the normal blood pressure range as a circle on a coordinate plane makes it possible to compare the normal reference circle and a patient's reading simultaneously. Therefore, the objective of this study is to plot blood pressure (systolic/diastolic) data on a coordinate plane, represent the normal blood pressure range using the equation of a circle, and visually determine abnormal blood pressure regions.

II. Theoretical Background

1. Normal Blood Pressure Standards and Clinical Classification

Blood pressure is expressed as the ratio of systolic blood pressure to diastolic blood pressure (mmHg). According to clinical guidelines from the Health Insurance Review & Assessment Service (HIRA) and basic nursing standards, readings of ~90/~60 mmHg indicate hypotension, 120/80 mmHg represents the normal standard, 120–129/80 mmHg corresponds to the elevated (caution) stage, 130–139/80–89 mmHg indicates prehypertension, and 140–160/90–100 mmHg is classified as hypertension.



2. Mathematical Definition of the Equation of a Circle

The equation of a circle is a mathematical expression representing the locus of all points on a coordinate plane that lie at an equal distance (radius) from a fixed point (the center). When (a, b) denotes the center coordinates of the circle, r denotes the radius, and (x, y) represents any point on the circumference, the standard form is expressed as $(x - a)^2 + (y - b)^2 = r^2$, as illustrated in Figure 1(a).

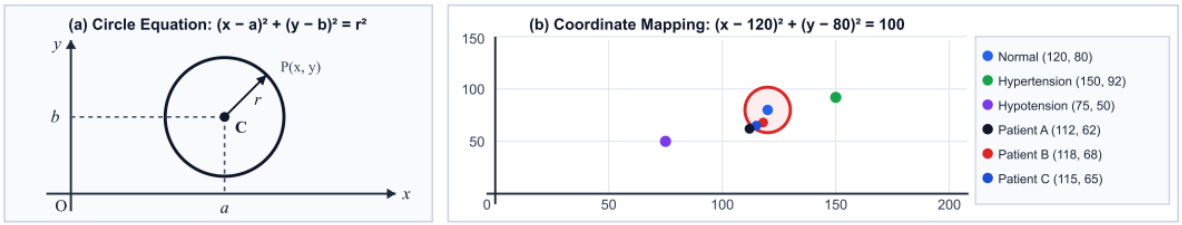


Figure 1. Geometric Principle of the Circle Equation (a) and Desmos Coordinate Plane Visualization of Blood Pressure Data (b)

III. Research Methodology & Data Collection

1. Study Design and Data Collection

Based on peer blood pressure measurements recorded during the school health checkup conducted on July 7, 2025, three actual student datasets (Patients A, B, and C) were collected, and two simulated abnormal blood pressure datasets (one hypertensive patient and one hypotensive patient) were prepared for comparative analysis. Just as normal blood pressure is written as (120, 80), systolic blood pressure was plotted along the x-axis and diastolic blood pressure along the y-axis.

2. Data Modeling and Plotting the Normal Circle

The center of the normal blood pressure circle was set at (120, 80). Because an error margin of up to 10 mmHg from the standard reading is clinically regarded as falling within the normal range, the radius of the circle was set to r = 10. Using the circle equation $(x - 120)^2 + (y - 80)^2 = 100$, the normal boundary circle was drawn, and coordinate points for the normal reference, hypertensive patient, hypotensive patient, and Patients A, B, and C were plotted by color on the coordinate plane to evaluate their status and determine appropriate nursing care.

IV. Results & Clinical Nursing Analysis

Table 1. Collected Blood Pressure Coordinates, Circle Equation Evaluation, and Clinical Nursing Care

Subject Group	Systolic (x)	Diastolic (y)	Coord. (x, y)	$(x-120)^2+(y-80)^2$	Coordinate Plane Position	Clinical Nursing Care Plan
● **Normal Ref.**	120	80	(120, 80)	0 ($r^2 = 100$)	Center of normal circle	Maintain healthy lifestyle & routine checkups
● **Patient B**	118	68	(118, 68)	148	Nearly touching lower boundary	Closest to normal range; routine monitoring
● **Patient C**	115	65	(115, 65)	250	Adjacent to lower-left boundary	Near normal; encourage adequate hydration
● **Patient A**	112	62	(112, 62)	388	Near lower-left outer boundary	Near normal; check for orthostatic dizziness
● **Hypertension**	150	92	(150, 92)	1,044	Far outside toward upper-right	Low-sodium diet, rest, re-measurement & referral
● **Hypotension**	75	50	(75, 50)	2,925	Far outside toward lower-left	Leg elevation, fall prevention & prompt reporting

A data point located inside or close to the circle indicates proximity to the normal blood pressure range. Accordingly, Patient B (118, 68), Patient C (115, 65), and Patient A (112, 62) are positioned nearly touching the lower edge of the circle, demonstrating that their readings are close to the normal standard. Conversely, the hypotensive patient (75, 50) lies far outside the circle to the lower left, while the hypertensive patient (150, 92) is positioned far outside the circle to the upper right, visually confirming severe deviations requiring targeted nursing intervention.

V. Conclusion & Reflections

1. Summary of Findings

Drawing inspiration from the equation of a circle, this study plotted blood pressure data on a coordinate plane and compared them against a normal reference circle. Through the graph, numerical differences can be verified at a glance, and blood pressure distributions across multiple individuals can be understood much more easily. Compared to listing raw numbers, this visual method intuitively reveals both the distance and direction from the normal range, enabling effective identification of group distributions and outlier cases simultaneously.

2. Reflections and Implications

Initially, transferring blood pressure readings onto a coordinate plane felt like simply solving a math problem. However, this investigation revealed that expressing blood pressure visually through a coordinate plane and a circle allows far more intuitive comprehension than viewing raw figures alone. Setting the normal range as a circle and plotting multiple individuals together demonstrated high efficiency in data interpretation. Above all, recognizing that mathematical graphing is not merely a calculation tool but a practical instrument for analyzing real-life health problems highlighted the importance of data visualization skills.

References

[1]. Desmos Studio PBC. (2025). Desmos graphing calculator (Version 2025) [Web application software]. https://www.desmos.com/calculator

[2]. Health Insurance Review & Assessment Service [HIRA]. (2024). Hyeol-ap jeongsang beom-wi annae [Guide to normal blood pressure ranges]. HIRA Health Information Portal.

[3]. Hong, J. G., et al. (2022). Gongtong suhak 2 [High school common mathematics 2]. Chunjae Education. (Original work published in Korean)

[4]. Kim, H. L., Lee, E. M., Ahn, S. Y., Cho, E. J., Kim, H. C., Kim, J. H., Kim, K. I., Kim, W., Park, J. H., Park, S., Shin, J., Sung, K. C., & Ihm, S. H. (2023). The 2022 focused update of the 2018 Korean Hypertension Society guidelines for the management of hypertension. Clinical Hypertension, 29(1), Article 11. https://doi.org/10.1186/s40885-023-00234-9

[5]. Kim, Y. H., et al. (2020). Gicho ganho imsang silmu [Basic clinical nursing practice]. Nursing Publishing Co. (Original work published in Korean)

[6]. Potter, P. A., Perry, A. G., Stockert, P. A., & Hall, A. M. (2021). Fundamentals of nursing (10th ed.). Elsevier Health Sciences.

[7]. Stewart, J., Clegg, D. K., & Watson, S. (2020). Calculus: Early transcendentals (9th ed.). Cengage Learning.

[8]. West, V. L., Borland, D., & Hammond, W. E. (2015). Innovative information visualization of electronic health record data: A systematic review. Journal of the American Medical Informatics Association, 22(2), 330–339. https://doi.org/10.1136/amiajnl-2014-002955

[9]. Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Dennison Himmelfarb, C., DePalma, S. M., Gidding, S., Jamerson, K. A., Jones, D. W., MacLaughlin, E. J., Muntner, P., Ovbiagele, B., Smith, S. C., Spencer, C. C., Stafford, R. S., Taler, S. J., Thomas, R. J., Williams, K. A., & Wright, J. T. (2018). 2017