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Exploration of longitudinal data based on integrated elderly health care for developing predictive health status in Semarang, Indonesia

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Abstract

Purpose: This study aims to explore and describe vital sign measurements in the 20 periods. **Methods:** This study used data from a database of integrated elderly healthcare at PHC Kedungmundu, focusing on 20 periods from January 2022 to August 2023, and employed a cross-sectional study design. In total, 715 participants were included in the 20 periods. Demographic and vital sign measurement data were merged with those of the respondents. The essential sign measurements were analyzed by age group (45-59, 60-74, and >75) for males and females, and by period using a box plot. Data was analyzed descriptively (proportion, mean, median) using Stata 13. **Results:** A total of 2,930 participants were included in the 20 periods. Most participants were female (88%) and were between 60 and 74 years old (52%). Healthcare professionals regularly record blood pressure every month, but not all participants provided data on BMI, waist circumference, blood sugar levels, uric acid levels, and cholesterol levels. SBP and DBP were higher in females, especially 60-74 years old (SBP= 141 mmHg, DBP=83 mmHg). BMI (26.04 kg/m^2) and waist circumference (87.94 cm) were higher in females than males. Blood sugar (169 mg/dL), uric acid (7.3 mg/dL), and cholesterol (230 mg/dL) data are also higher in females than in males, especially among those aged 45-49 years old. **Conclusion:** Investigated the health status of the elderly over 20 months, gender and age-related differences in health metrics, and chronic disease risk factors. Tailored health interventions and regular monitoring are crucial for effectively managing and mitigating the risk factors that affect long-term health outcomes and quality of life.

Keywords: integrated health care systems; longitudinal; population surveillance; vital signs

INTRODUCTION

The number of elderly people (60 years and older) in 2020 was 9.9% of Indonesia's total population and is predicted to reach 15.77% by 2035 [1]. The prevalence of diabetes mellitus and hypertension increases with age. An increase in the prevalence of diabetes mellitus occurred in the 55-64-year-olds, around 6.29%. In addition, the most significant increase in the prevalence of heart disease occurred in the 45-54-year-old age group, at 2.4%. Stroke has also increased in prevalence among people aged 55 to 64 years [2].

During the COVID-19 pandemic, the elderly and individuals with non-communicable diseases (NCDs) were the groups most at risk of dying from COVID-19 [3]. Of deaths due to COVID-19, 95% occurred in the age group >60 years, and 50% occurred in the age group >80 years. Data showed that 8 out of 10 deaths occur in individuals with comorbidities, especially cardiovascular [4]. Older adults facing various disease risks need to increase routine health status monitoring. A proper and functional health monitoring system is developed through sustainable health checklists [5]. Sustainable elderly health services require routine implementation and formal and non-formal support [6].

To meet the health service needs of the elderly, the Government established an integrated elderly service post, known as Kelompok Usia Lanjut/POKSILA. POKSILA is a health monitoring activity that starts with pre-elderly individuals (45-59 years) and continues for the elderly (>60 years). It is carried out once a month through promotive and preventive measures. Examinations are usually carried out to measure blood pressure, body mass index, HB levels, cholesterol levels, blood sugar levels, health education, and the provision of additional food [7]. Surveillance at the community level captures and records information related to the health of the elderly, such as daily activities and vital signs [3].

According to data from the Central Bureau of Statistics, the life expectancy in Indonesia in 2022 is expected to be 71.85 years. Meanwhile, Central Java holds Indonesia's third-highest life expectancy position, at 74.57 years, while Semarang has a life expectancy of 75.86 years. The number of older adults in Semarang has reached 180,096 [8].

Community-based health screening and encouraging individuals with high blood pressure to seek care and adopt behavioral changes. A decrease in blood pressure has a significant long-term impact on systolic blood pressure at the population level. This approach could address the high burden of cardiovascular disease in a country with unmet needs for cardiovascular diagnosis and treatment [9].

There is a need to expand risk factor monitoring and integrated outcome monitoring in one system to overcome the NCD epidemic in Indonesia. The health system needs to be developed in a practical, realistic, and affordable way to prevent and control NCDs through a structured approach [10]. Research on the health of the elderly in Hong Kong indicates that vital signs that often experience significant changes include systolic and diastolic pressure, as well as body temperature. In addition, individuals at high risk of chronic disease and falls must carry out early detection and health management. Not being treated immediately will cause extended hospitalization [11].

The participation of the elderly in using POKSILA is crucial in seeing the impact of program implementation. The coverage of POKSILA organizers can be increased by holding these activities at strategic times, not during working hours, and empowering cadres [12]. In Semarang, the scope of elderly health service activities in 2020 was 86% [13]. By looking at these figures, the data collected in POKSILA activities is quite large and can be used to make predictions about the health of the elderly. Based on IFLS 5 data, most elderly prefer to seek treatment from a nurse or midwife (30.5%), followed by a community health center (30.3%) [14]. Access to government-provided health insurance increases the number of elderly visits to community health centers for treatment [15]. Surveillance systems can collect data from entire communities over time and reflect the health and population problems of developing countries. In addition, this system can monitor new health problems, track population changes and deaths, and measure interventions carried out by the government [16].

Existing big data can be identified for its suitability and can also be used to see actual conditions. In addition, data on risk factors, outcomes, and intervention programs are essential to complete this analysis. Existing data can be used for accurate predictions. Digital transformation in the public health sector needs to increase the efficiency and sustainability of the health service system [17,18]. So far, data in POKSILA has not been integrated between cycles and has never been analyzed, so this study aims to explore and describe vital sign measurements in the 20 periods. Estimates of elderly health based on personal identification can be used for early detection and treatment of health issues in older adults.

METHODS

Data source

This study used secondary data from a database of integrated elderly healthcare (POKSILA) at the Public Health Center (PHC) Kedungmundu, Semarang. Paper-based documentation of PHC Kedungmundu was collected and then made digitally. PHC Kedungmundu has the highest total number of elderly and POKSILA in Semarang. POKSILA is a community-based health screening for the elderly that is conducted periodically, once a month, including the collection of primary demographic data and vital sign measurements. This study focuses on 20 periods of POKSILA, conducted from January 2022 until August 2023. The list of the POKSILA period is represented in Table 1. The study was conducted using a cross-sectional study design.

Table 1. The Month of POKSILA held in PHC Kedungmundu, Semarang

The month of POKSILA held	Number of participants	The month of POKSILA held	Number of participants
January 2022	80	November 2022	207
February 2022	104	December 2022	158
March 2022	115	January 2023	181
April 2022	0	February 2023	246
May 2022	165	March 2023	194
June 2022	143	April 2023	100
July 2022	175	May 2023	144
August 2022	160	June 2023	219
September 2022	205	July 2023	187
October 2022	194	August 2023	69

Study sample

In total, 715 participants were included in the 20 periods of POKSILA. Demographic and vital sign measurement data were merged with the respondents' data for 20 periods. This study only selected individuals 45 years old and older. Because POKSILA concerns pre-elderly (45–59 years) and the elderly (>60 years). [7] Individuals under 45 years of age were excluded from the analysis. The data analysis included only 682 respondents from 20 periods of POKSILA. Figure 1 represents the flowchart of respondents.

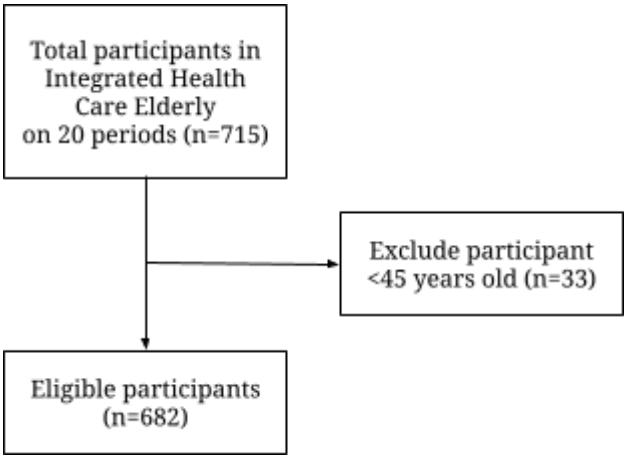

Figure 1. Respondent flowchart

Demographic and vital sign measurement data

Demographic data such as date of birth, sex, and location are required to describe the characteristics of the respondents. Vital sign measurement data included systolic blood pressure (SBP) and diastolic blood pressure (DBP), blood sugar, uric acid, and cholesterol levels. The data on anthropometric measurements included body weight, height, and waist circumference. All data were secondary collected from the documentation of PHC Kedungmundu.

Statistical analysis

The characteristics of the study population were described using medians and quartiles for continuous variables. Data for blood pressure at all ages (45-59, 60-74, and >75) for males and females were analyzed by period. SBP and DBP are represented separately. Data on body mass index (BMI) was calculated as weight (kg) divided by height (m^2), and central obesity was determined based on waist circumference. Data about blood sugar, uric acid, and cholesterol levels are also described as continuous variables. To ensure a fair comparison, a box plot was used to choose the same distribution for all subgroups within each vital sign measurement. The descriptive analysis was also performed using mean ± standard deviation. All analyses were undertaken using Stata 13 [19]. The Komite Etik Penelitian Kesehatan (KEPK) at Universitas Negeri Semarang, Indonesia, approved this study (No. 298/KEPK/EC/2023).

RESULTS

This study captured the POKSILA in 20 monthly periods from January 2022 until August 2023. The age group was divided into three categories: 45-59, 60-74, and 75 years old and above. Several participants from the age group attended each period. The total number of participants who visited POKSILA in the 20 periods was 2,588. Most participants were female (88%) and were between 60 and 74 years old (52%). The period with the most participants was period 14 (February 2023) (Table 2).

The vital sign measurement data for 20 periods were displayed in a box plot by sex and age group. However, the attendance percentage of each participant during the 20 cycles varies (55-90%) (Table 2). Healthcare professionals in POKSILA regularly record their monthly blood pressure, including systolic (SBP) and diastolic (DBP) readings.

Data showed that SBP was higher in females than in males. The 60-74 year old age group (SBP = 141 mmHg) has a higher systolic blood pressure (SBP) than the other age groups. For DBP, females (DBP = 83 mmHg) have a higher DBP than males. Individuals aged 60-74 years have the highest DBP. Tren DBP in 20 periods tends to decrease (%) (Figure 2)

Table 2. Total participants per period by sex and age group

Period	Male				Female			
	45-59	60-74	>75	Total	45-59	60-74	>75	Total
1	2	10	5	17	25	34	2	61
2	1	8	3	12	47	39	3	89
3	1	4	1	6	52	51	4	107
4	0	0	0	0	0	0	0	0
5	3	10	1	14	71	76	4	151
6	5	3	1	9	62	64	8	134
7	2	10	2	14	55	77	9	141
8	2	12	3	17	66	68	5	139
9	6	10	2	18	83	86	8	177
10	6	17	2	25	76	77	7	160
11	7	15	4	26	80	90	6	176
12	4	13	2	19	63	69	7	139
13	6	11	2	19	68	77	6	151
14	10	15	4	29	90	104	10	204
15	4	18	3	25	64	86	10	160
16	3	13	2	18	34	41	2	77
17	5	14	2	21	49	64	2	115
18	5	22	2	29	77	96	9	182
19	5	14	3	22	62	85	11	158
20	0	1	1	2	30	33	4	67
Total	77	220	45	342	1,154	1,317	117	2,588

Not all participants provided the data, resulting in several incomplete data points. Data include body mass index (BMI), waist circumference, blood sugar level, uric acid level, and cholesterol level. The box plot seems incomplete for these data because there is no data about that. The BMI boxplot showed that females' BMIs are higher than those of males, especially those aged 45-59 years old. Participants who are 75 years old or older have the lowest BMI in the community. According to waist circumference data, females have a higher waist circumference than males. The 60–74–year–old age group has the highest waist circumference level in the community (Figure 3). Vital sign measurements for blood sugar levels showed that the class is higher in females than in males. Additionally, individuals aged 45-59 have the highest levels. For uric acid levels, females aged 45–59 years have the highest levels. Cholesterol levels also showed the same result; females aged 59-74 have the highest level (Figure 4). Each indicator showed a decreasing level, and over the 20 periods, it also helped maintain the health of older adults (Figure 4).

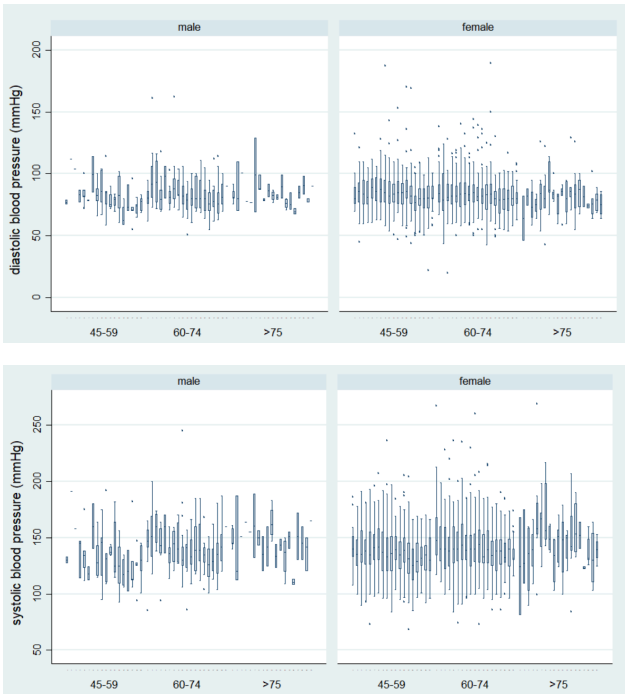

Figure 2. Systolic and diastolic blood pressure by sex and age group over the 20 years

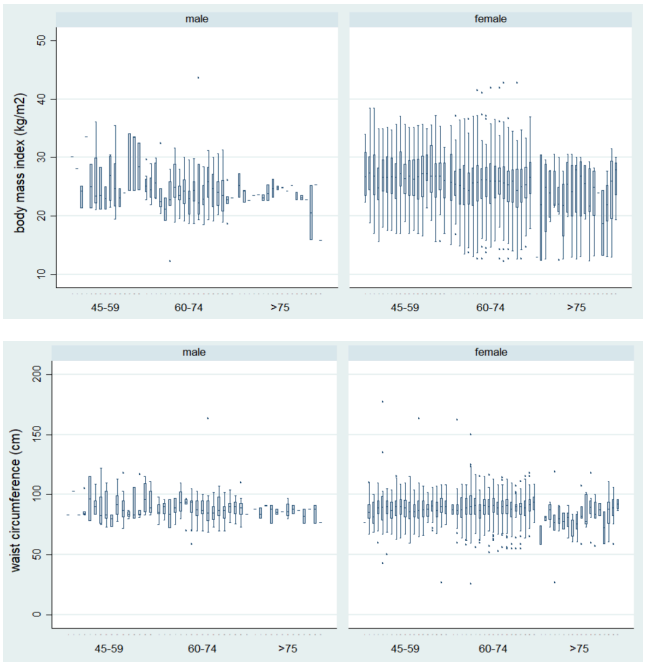

Figure 3. Body mass index (BMI) and Waist Circumference by sex and age group in 20 periods

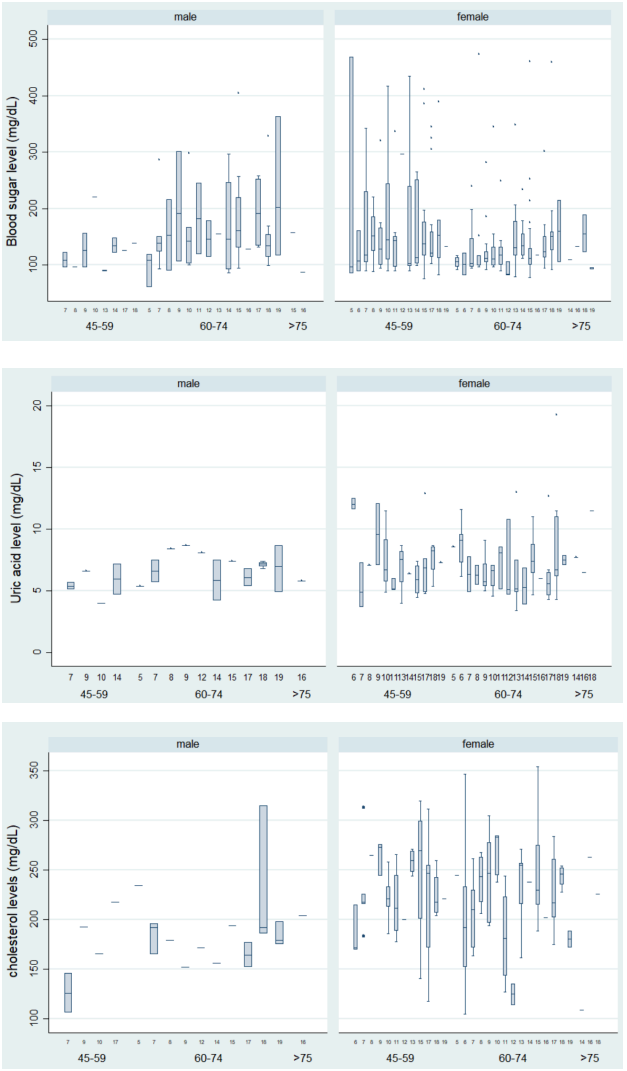

Figure 4. Blood sugar, uric acid, and cholesterol levels by sex and age group in 20 periods

DISCUSSIONS

Based on this research, the number of participants was higher among women than men. More than half of the respondents were female and were between 60 and 74 years old. This study suggests that increasing age will also increase the burden of diseases that require health services. Women are usually more concerned with health problems they experience, so women often use health facilities to maintain their health [12]. Population aging, associated with an increased risk of chronic diseases and disability, is one of the most important demographic changes in many countries. Anthropometric indicators are simple, portable, non-invasive, inexpensive, and easy-to-apply measures that can be easily applied to the elderly to guide preventive and intervention efforts [20].

During 20 periods, systolic blood pressure tends to increase than diastolic. Isolated systolic hypertension, an increase in systolic blood pressure but not diastolic, is the most common type of high blood pressure in people 50 years of age and older, occurring recently or after a long period of high blood pressure, with or without treatment. The increase in blood pressure with age is mainly related to changes in the structure of the arteries, including the stiffness of large arteries. Several studies have shown that increased blood pressure is associated with an increased risk of cardiovascular disease. In older adults, the most potent risk predictor is hypertension due to decreased diastolic blood pressure and increased systolic blood pressure. All evidence indicates that the treatment of elderly hypertensive patients reduces the risk of cardiovascular events. However, there is still no evidence for the elderly. This population is susceptible to treatment side effects and reduced blood pressure, although the reduction in risk of cardiovascular events, such as stroke, may lead to increased mortality [21].

This research found that BMI and abdominal circumference are higher in young people under 60, and BMI tends to decrease in older people. It is related to research from Korea and Indonesia that shows the 80-year-old group commonly has a BMI of less than 18.5 kg/m². The use and interpretation of BMI may be more limited in older adults, who often experience muscle loss with age and an increase in visceral fat due to the redistribution of adipose tissue [22,23]. The prevalence of central obesity has increased, especially in older women. Women physiologically have a higher percentage of body fat and a higher overall weight than men, and experience height loss, which occurs earlier and is more severe in men. Research data found that men's waist circumference increased from pre- to old age but remained within the normal range (waist circumference <90 cm), while women's waist circumference increased from the pre-age period to the elderly stage. Older age is associated with central obesity, characterized by a waist circumference of 80 cm or more; waist size tends to increase with age. Central obesity in the elderly can be detected by examining the increase in waist circumference from pre- to old age. This increase is due to weight gain, fiber consumption, chronic diseases, and physical inactivity [24].

The analysis demonstrated a negative trend between a patient's age and the random blood sugar (RBS) level, which aligns with the findings of a previous study conducted in Ethiopia [25]. According to Andargie and Zeru, the RBS level is projected to decrease by 0.44 mg/dL for every one-year increase in a patient's age, while keeping the influence of other factors unchanged [26]. Blood glucose levels also differ by sex. Healthy women have lower skeletal muscle mass and higher adipose tissue mass, more circulating free fatty acids (FFA), and higher intramyocellular lipid content than men of the same age. All of these factors may contribute to insulin resistance in women [27].

A study conducted in Germany has found that serum uric acid levels increase in both men and women as they age. Hyperuricemia is more prevalent in men than women, especially premenopausal women. Estrogen levels stimulate the renal excretion of uric acid, which accounts for the observed differences in age and gender [28]. Estrogens enhance the elimination of uric acid by the kidneys and reduce the concentration of serum uric acid (SUA) by inhibiting the production of the proteins responsible for reabsorbing urate, such as URAT1 and GLUT9, in the proximal tubule. Additionally, estrogens also decrease the levels of the urate efflux transporter ABCG2. This mechanism suggests that higher estrogen levels in premenopausal women lead to increased uric acid removal by the kidneys [29].

The Study of Women's Health Across the Nation (SWAN) demonstrated a rise in total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels within one year after the cessation of menstruation. This study also indicated that elevations in both indicators are associated with an augmented risk of developing cardiovascular disease (CVD). With increasing age, women tend to have higher serum concentrations of triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and total cholesterol (TC) compared to men. Menopause, regardless of chronological age, is linked to a higher occurrence of dyslipidemia, but not hypertension or insulin resistance, separate from the impact of aging [30].

This study on elderly health in Semarang, Indonesia, provides valuable insights and has significant implications for research, practice, policy, and social impact. It highlights key trends in health indicators, such as blood pressure, BMI, waist circumference, and blood glucose levels, while also emphasizing gender and age-related differences. For researchers, the data support further investigation into these health trends and the development of predictive models. Healthcare providers can use these findings to improve monitoring and create personalized care plans, especially for high-risk groups, such as older women. Policy-wise, the study informs the design of health policies promoting regular screenings and preventive care, and supports better resource allocation and community health programs. Socially, it raises awareness about health challenges among the elderly and empowers older women to take charge of

their health. Implementing the study's recommendations can lead to improved health outcomes and quality of life for the elderly, reducing the prevalence of chronic diseases and enhancing overall well-being.

CONCLUSION

This study examined the health status of elderly individuals in Semarang, Indonesia, over a 20-month period. The findings reveal significant gender and age-related differences in health metrics and chronic disease risk factors, such as The majority of participants were female (88%) and aged 60-74 years (52%), indicating higher healthcare engagement among older women, systolic blood pressure was generally higher in females, particularly in the 60-74 age group (141 mmHg), while diastolic blood pressure showed a decreasing trend over the 20 periods, body composition for females, especially those aged 45-59, had higher BMI and waist circumference compared to males. BMI tended to decrease in the oldest age group (>75 years), blood sugar, uric acid, and cholesterol levels were generally higher in females, with the 45-59 age group showing the highest levels for blood sugar and uric acid.

Overall, this research highlights the importance of tailored health interventions and regular monitoring of vital signs in the elderly population to effectively manage and mitigate chronic disease risks. Most indicators showed fluctuations but generally remained the same or decreased over the 20 periods, suggesting that regular monitoring may have had a positive impact on elderly health. Non-invasive and straightforward anthropometric measures can guide preventive and intervention strategies in this demographic.

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