

Comparative analysis of disability-adjusted life years (DALY) in people with diabetes mellitus between Central Java and Yogyakarta

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ABSTRACT: Diabetes mellitus (DM) is a non-communicable disease with an increasing health burden. Differences in disease burden in Indonesia can be attributed to various factors. Therefore, a comparative analysis of disease burden based on Disability-Adjusted Life Years (DALY) is needed to understand the differences in the epidemiological characteristics of DM in Central Java and Yogyakarta. This study is a comparative descriptive study with a quantitative approach using secondary data. DALY and its components were analyzed to observe trends, calculate the Compound Annual Growth Rate (CAGR), and statistically tested using independent t-test to assess differences in DALY values between Central Java and Yogyakarta. The values showed an increasing trend in both provinces during the observation period. Yogyakarta had significantly higher DALY values than Central Java, with an average DALY rate of 1062.48 in Yogyakarta and a DALY rate of 807.01 in Central Java ($p < 0.05$). The increase in illness burden was greater in Yogyakarta (2.38%) compared to Central Java (2.21%). The ratio of Years of Life Lost (YLL) exceeded that of Years Lived with Disability (YLD), signifying that diabetes mellitus (DM) exerted a more significant influence on untimely mortality than on disability. These results emphasize the need for regional health policies that focus on preventing premature death and strengthening early detection of DM.

KEYWORDS: Diabetes mellitus; Disability-Adjusted Life Years; Years Lived with Disability; Years of Life Lost.

INTRODUCTION

Diabetes mellitus (DM) is a non-communicable disease with a rapidly rising global burden. According to the Global Burden of Disease (GBD) study 2021, the prevalence of DM has reached over 529 million cases worldwide, doubling since 1990, and is projected to reach 1.3 billion cases by 2050 [1]. DM poses a significant public health problem in Indonesia, with a large and increasing burden of cases in recent decades.

The prevalence of DM is projected to increase from 9.19% in 2020 (18.69 million cases) to 16.09% in 2045 (40.7 million cases), an increase of 75.1% over 25 years, or an average of 3% per year. The Java-Bali region has the highest prevalence compared to other regions in Indonesia. Furthermore, without intervention, the number of deaths due to DM and its complications (such as stroke, ischaemic heart disease, and chronic kidney disease) is also estimated to more than double, from 433,752 deaths in 2020 to 944,468 in 2045 [2].

DM has an impact on the health burden not only in terms of high mortality rates, but also chronic complications that cause a decline in the quality of life of sufferers and an increase in the need for long-term health services in the health system. DM contributes significantly to the burden of disease that can lead to the loss of healthy years of life due to premature death (years of life lost, YLL) and chronic disability (years lived with disability, YLD). These two indicators are integrated into the measurement of Disability-Adjusted Life Years (DALY), which provides a comprehensive picture of the disease burden in terms of both mortality and morbidity. The GBD analysis shows that most of the disease burden due to DM comes from a combination of YLL and YLD, with factors such as obesity (high BMI) being the main contributors to global DM DALY. This indicates that preventing metabolic risk factors will reduce both premature death and disability due to DM [1].

A GBD study of Indonesian provinces shows significant disparities in the burden of disease-adjusted life years (DALY) due to chronic diseases, including diabetes. The variations in disease burden across regions may

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be attributable to demographic, economic, and socio-cultural factors [1]. Consequently, a comparative investigation of the disease burden utilizing DALY metrics is imperative to elucidate the disparities in the epidemiological characteristics of DM across various regions. Yogyakarta and Central Java are two neighbouring regions that are among the top 10 regions with the highest prevalence of diagnosed DM in Indonesia, with values of 2.9% and 1.8% respectively. Both regions are certainly affected by the burden of DM [3].

However, there are still few studies comparing DALY values of DM especially between Central Java and Yogyakarta. Thus, this study aimed to analyse the differences in DALY values and their components due to DM in Central Java and Yogyakarta so as to provide a basic overview that can be used to formulate more specific health policies in accordance with the regional context, both in terms of preventing premature death and managing chronic complications caused by DM. This study's hypothesis is that the DALY value due to DM in Yogyakarta will be higher than in Central Java. Furthermore, the YLL component will provide a greater contribution than YLD to the disease burden in both regions. The results of this study should provide an epidemiological basis for prioritising region-specific initiatives, especially efforts for preventing premature mortality and improving early detection and long-term management of DM.

▪ MATERIALS AND METHODS

Research design

This study utilized a quantitative, comparative-descriptive design based on secondary data analysis. Descriptive studies can describe the health status of a particular population based on people, time, and place [4]. The study was conducted to describe and compare the burden of DM based on the Disability-Adjusted Life Years (DALY) indicator between Central Java and Yogyakarta.

The data for this study were obtained from the Institute for Health Metrics and Evaluation (IHME) in 2022. The data can be accessed from <https://vizhub.healthdata.org/gbd-results/>. The *website dashboard* has an indicator filter feature that can be used to organise data according to research needs. Once the filter has been applied as required, the data can be downloaded in CSV format.

Data sources

Estimates for Years of Life Lost (YLL), Years Lived with Disability (YLD), and Disability-Adjusted Life Years (DALY) were derived from the Global Burden of Disease (GBD) Study 2021 database, executed by the Institute for Health Metrics and Evaluation (IHME). Epidemiological metrics were retrieved via the GBD Results Tool (<https://vizhub.healthdata.org/gbd-results/>) by applying specific filtering criteria, including burden estimates, metric types, measurement units, underlying causes, geographic locations, and demographic stratification. The relevant data spanning from 2006 to 2021 were exported in CSV format for subsequent quantitative evaluation.

Data analysis

The data downloaded from GBD 2021 in CSV format was then processed using numerical processing software. Data processing in the software included converting the data obtained into diagrams so that the data was easier to present and understand. Data processing also aimed to identify trends in the fluctuations of each indicator, namely YLL, YLD, and DALY, within the specified time frame. The extracted data was then analysed using the *Compound Annual Growth Rate* (CAGR) calculation to determine the growth rate of YLL, YLD and DALY in both provinces. The CAGR value can be calculated using the following formula.

$$CAGR = \left(\frac{V_t}{V_0} \right)^{\frac{1}{t}} - 1$$

Explanation:

V_0 = initial value (e.g. number of cases/prevalence in the initial year)

V_t = final value (e.g. number of cases/prevalence in the final year)

t = number of years (time period)

In addition, data analysis was also performed using SPSS 24 to test the normality of the data and to test the difference between the DALY data for Central Java and Yogyakarta. The normality test in this study was conducted using the Kolmogorov-Smirnov test. Subsequently, an independent t-test was applied when the data were normally distributed, whereas the Mann-Whitney test was used when the data were not normally distributed. The data analysis was used to determine the significant differences between the DALY component data trends from Central Java and Yogyakarta.

RESULTS

Profile of YLL values for Central Java Province and Yogyakarta Province

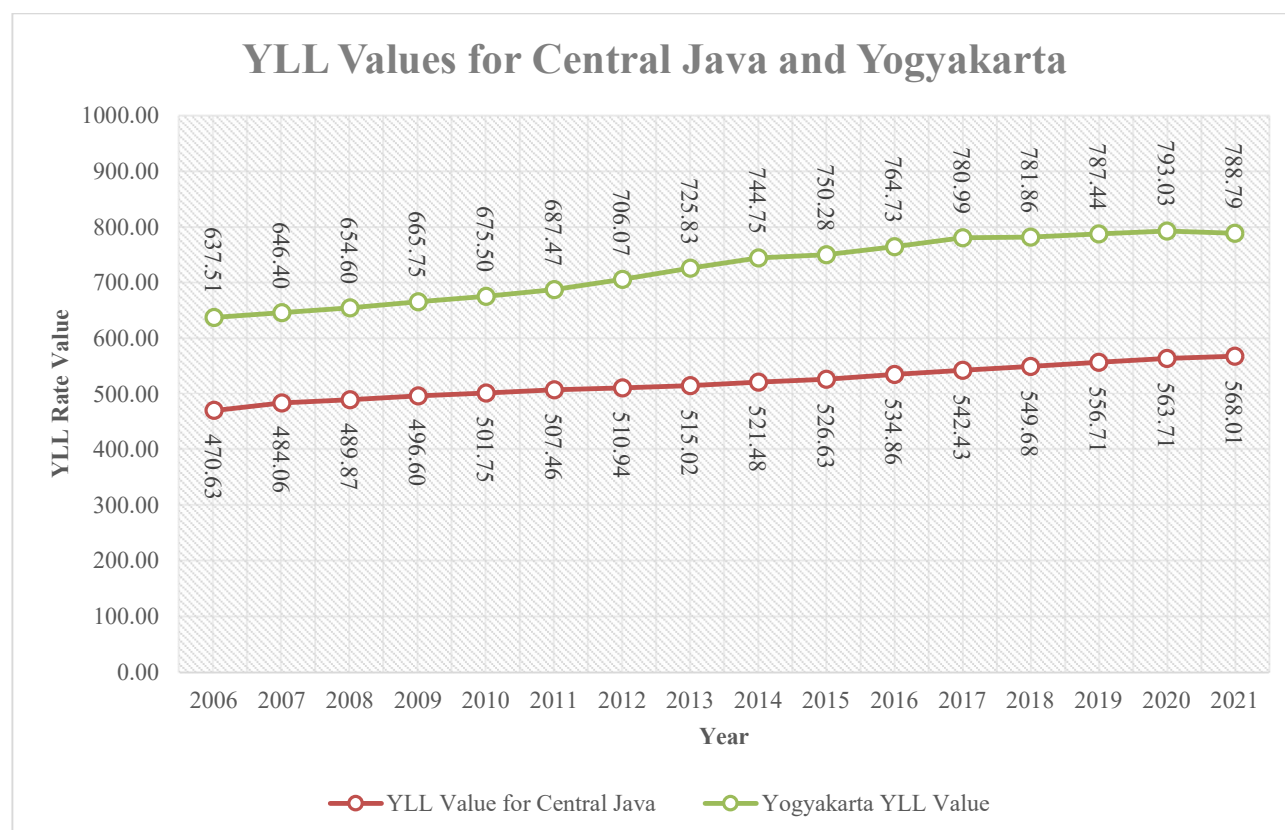


Figure 1. Graph of YLL values for central java and yogyakarta.

The annual development values of the YLL aspect of patients with DM in both provinces can be seen in Figure 1. The graph shows that both provinces have a trend of increasing YLL values, except in 2021 in Yogyakarta. In Central Java, the YLL value increased from 470.63 in 2006 to 568.01 in 2021, representing an increase of 97.38 point. Meanwhile, Yogyakarta showed a steeper increase of 151.28 point, from 637.51 in 2006 to 788.79 in 2021.

The growth in YLL values in Central Java is shown by a CAGR of 1.26%, while the CAGR for YLL values in Yogyakarta is 1.43%. This indicates that DM in Yogyakarta has a higher rate of causing premature death compared to DM in Central Java. It also indicates that despite various efforts, the burden of DM in terms of years of life lost due to premature death continues to worsen in both regions and DM sufferers in Yogyakarta are at greater risk of premature death than DM sufferers in Central Java.

Profile of YLD values for Central Java and Yogyakarta

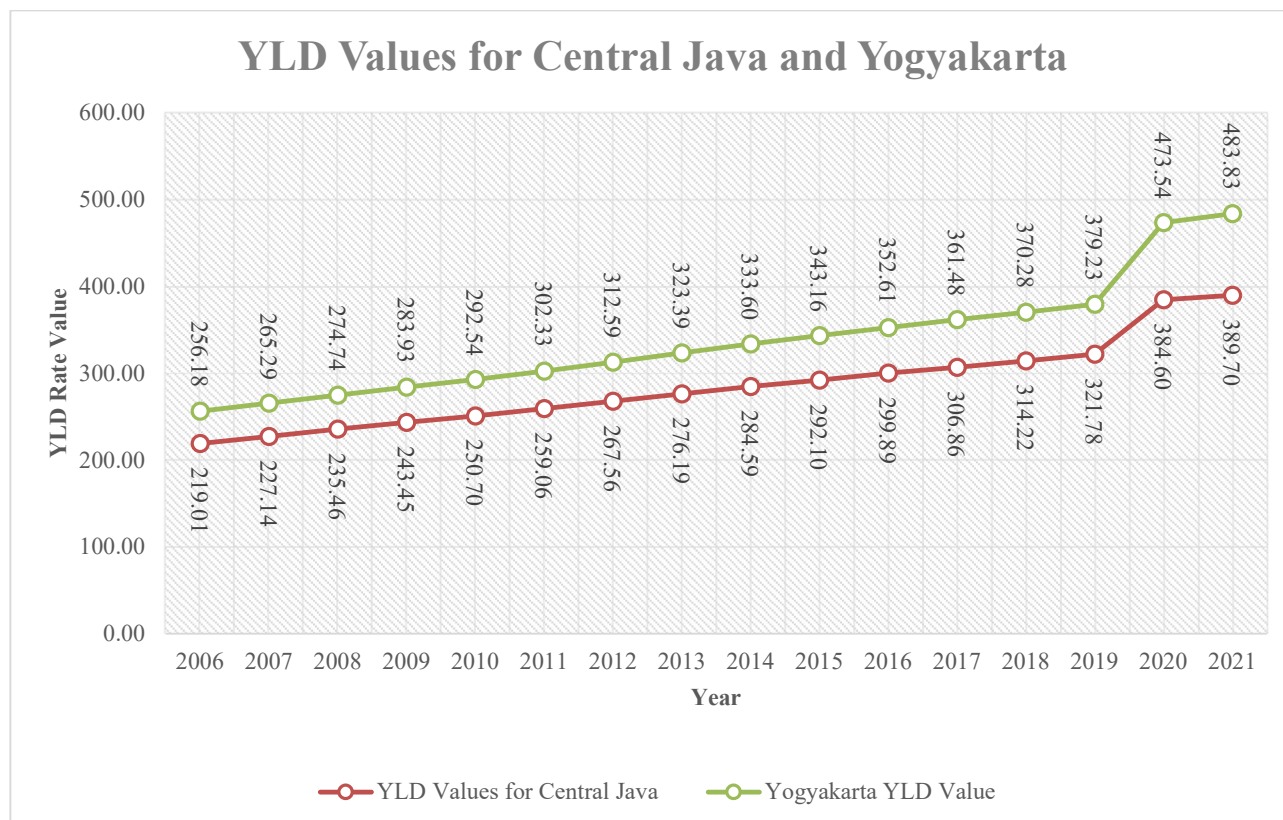


Figure 2. Graph of YLD values for central java and yogyakarta.

The YLD values for Central Java and Yogyakarta can be seen in Figure 2. The picture shows that the YLD values in both provinces have an upward trend. In 2006, the YLD value in Central Java was 219.01, and in Yogyakarta was 256.18. These values continued to increase until 2021, when the YLD rate had risen sharply to 389.70 in Central Java and 483.83 in Yogyakarta, with absolute increases during that period of 170.69 for Central Java and 227.65 for Yogyakarta. The increasing YLD values in both provinces indicate that DM is a disease that progressively causes long-term disability through microvascular and macrovascular complications, characterized by a decline in the quality of life of sufferers due to living with illness or disability [5].

Meanwhile, the CAGR value of YLD in Central Java experienced an average YLD growth of around 3.90% per year. Yogyakarta experienced faster YLD growth around 4.34% per year. This indicates that Yogyakarta not only has a higher disability base but also a faster rate of disability addition, indicating differences in disease control and the severity of risk factors in the Yogyakarta population.

DALY Value Profile of Central Java and Yogyakarta

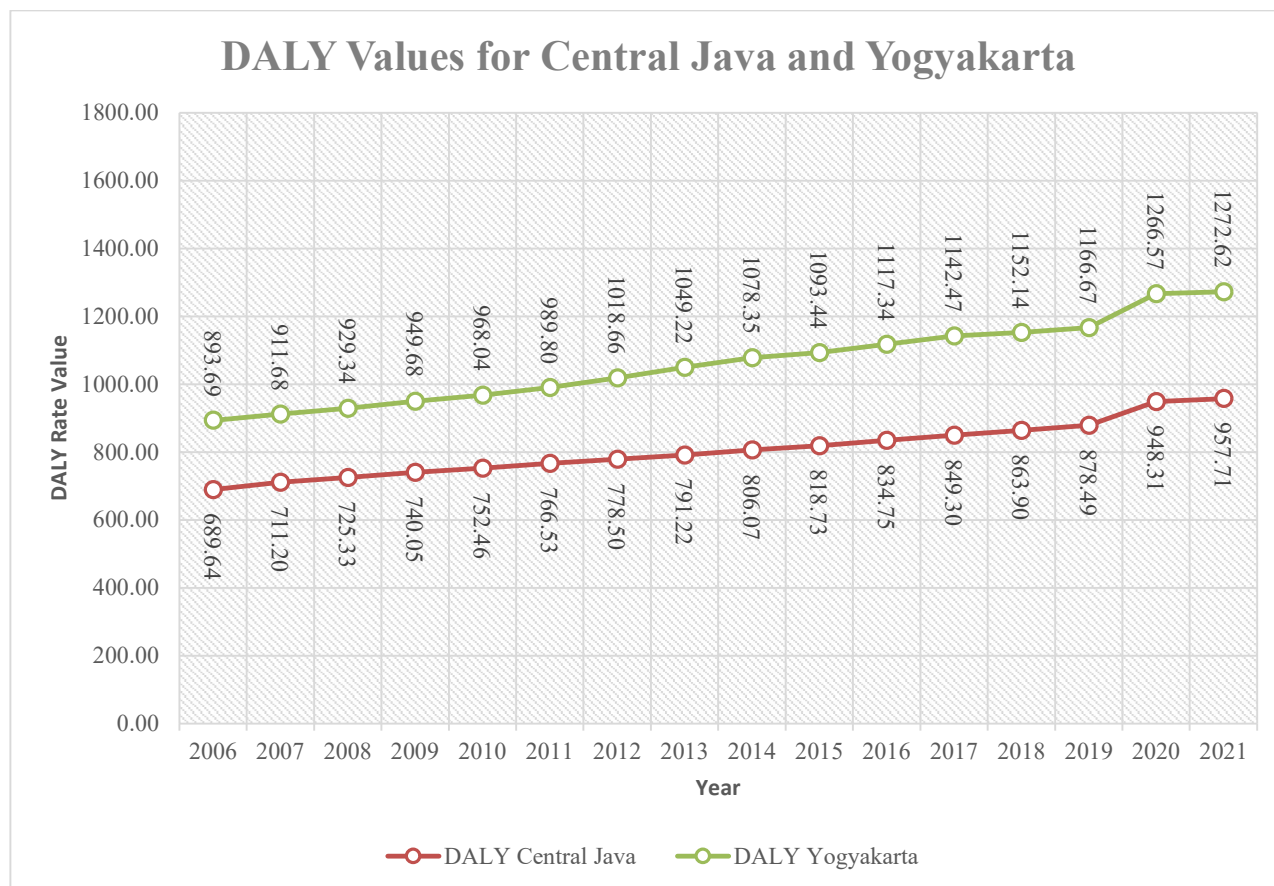


Figure 3. Graph of DALY values for central java and yogyakarta.

The development of DALY values for Yogyakarta and Central Java can be seen in Figure 3. The absolute DALY value for Yogyakarta over 15 years has always been greater than the DALY value for Central Java. The DALY value in Yogyakarta in 2006 was 893.69, which then continued to increase to 1272.62 with an absolute increase of 378.93. The DALY value for Central Java in 2006 was 689.64, increasing to 957.71 in 2021, with an absolute increase of 268.08. This increase not only reflects the growing burden of DM but also shows the widening gap between the two provinces. The widening gap between the two provinces can also be seen from the rate of growth in the burden of DM between the two provinces. The CAGR value for Central Java is 2.21%, while the CAGR value for Yogyakarta is 2.38%. These two values indicate that the increase in the burden of DM in Yogyakarta is faster and more severe than in Central Java.

Comparison of DALY Values for Central Java and Yogyakarta

Table 1. Comparison and analysis results of DALY values for central java and yogyakarta.

Statistical parameters	DALY values of Central Java	DALY values of Yogyakarta	P values
Mean	807.01	1062.48	< 0.001
Standard deviation	78.95	119.24	
Standard error of the mean	19.73	29.81	
Median	798.64	1063.79	

Table 1 presents comparative data and statistical analysis results for DALY values in Central Java and Yogyakarta. The table shows that statistical analysis of DALY values for Central Java and Yogyakarta reveals a significant difference with a $P \leq 0.001$. The result is in line with the trend shown in Figure 3, DALY values in Yogyakarta are significantly higher than DALY values in Central Java, both in terms of average DALY values and throughout the entire study period.

DISCUSSION

Figure 1 illustrates the trend of DM increasing premature mortality. Several aspects that can cause DM to increase premature mortality are the limited ability to detect it early in vulnerable populations in Yogyakarta. Data from Badan Pusat Statistik (BPS) shows that Yogyakarta has the highest elderly population in Indonesia at 16.28%, which has a greater potential for suffering from DM [3]. Early detection in populations vulnerable to metabolic diseases, namely the elderly, plays a crucial role. If there is a delay in early detection, the therapy used to manage DM will also be delayed, thereby increasing the risk of the disease worsening more quickly, which ultimately reduces the patient's life expectancy. This, of course, also has an impact on the YLL rate, which will increase from year to year.

It has been demonstrated by other studies that the absence of early detection of diabetes, whether attributable to a high number of undiagnosed cases or delayed diagnoses, has a substantial impact on the elevated rate of premature mortality observed among individuals diagnosed with diabetes. It is an established fact that patients with undiagnosed or late-diagnosed DM tend to have already entered a more advanced stage of the disease with complications. This, in turn, increases the risk of premature mortality YLL [6]. Another study also states that delayed diagnosis hinders early intervention to control hyperglycaemia, prevent complications, and improve lifestyle. A study in China reported that early diagnosis significantly reduced all-cause mortality and cardiovascular mortality in patients diagnosed with diabetes and undergoing management through lifestyle modification [7].

In addition, access to healthcare can impact the YLL value each year. Populations with limited access to healthcare will certainly receive delayed treatment, which can increase their mortality rate. Other studies have shown that limited physical and economic accessibility of healthcare services, as well as the lack of affordable medicines, can significantly increase the frequency of complications in patients with DM. This has the potential to increase premature mortality rates [8]. Based on the results of a review study, socioeconomic disparities limit access to medicines, thereby limiting the potential to improve diabetes management and overall quality of life in disadvantaged groups [9].

As illustrated in Figure 2, there is an upward trend in YLD values in both provinces. This disability may be attributed to complications arising from DM, which have an impact on quality of life. Based on other studies, individuals with diabetes experience an increase in sensory disturbances, symptoms of depression, and signs of depersonalization and derealization, which collectively impact the perception of health-related quality of life. It is evident that these factors, when considered in conjunction with age, have a substantial impact on the variability observed in total scores and sub-scores of health-related quality of life perception. This variability is particularly pronounced in domains such as general health perception, physical function, role limitations due to physical problems, vitality levels, and perceived pain [10].

The local demographic context highlights the urgency of the issue in Yogyakarta, where the elderly population is at higher risk of complications. The potential for greater complications in the elderly population is due to a decline in metabolism, which reduces the ability of organs to control blood sugar levels. Data from Statistics Indonesia (2024) shows that DIY ranks highest in terms of the proportion of elderly residents (16.28%) compared to other provinces in Indonesia [3]. This indicates a greater decline in quality of life and burden of disability due to DM in this region.

Figure 2 also shows a significant increase in both provinces from 2019 to 2020. This sharp increase may be due to the COVID-19 pandemic in 2019. The COVID-19 pandemic certainly exacerbated the condition of DM patients, increasing the likelihood of disability. One study states that the COVID-19 pandemic worsened the burden of complications in DM patients and directly and indirectly reduced their quality of life. SARS-CoV-2 infection in people with diabetes is associated with increased mortality and the risk of acute complications such as Acute Kidney Injury (AKI), inflammatory disorders, increased incidence of stroke, cardiovascular disease, and accelerated progression of kidney disease in people with diabetes, thereby increasing the burden of morbidity that impairs long-term function and quality of life [11].

In addition, the COVID-19 pandemic at that time caused access to health services to become very limited. This was due to *lockdown* policies, which meant that patients received limited treatment. A study in Oman showed that disruptions to healthcare services during the *lockdown* period and the COVID-19 wave phase (delays in routine visits, screening, HbA1c testing, and diabetic eye and foot care) led to a decline in metabolic

control, as evidenced by an increase in average HbA1c, systolic blood pressure, and Body Mass Index (BMI) in patients recorded before and during the pandemic. This increases the risk of complications. These disruptions impact patients' daily functioning and heighten anxiety, further reducing their quality of life [12].

The YLD value continues to show an upward trend and has a negative impact on various aspects of health. Therefore, intervention is required to suppress the increase in the YLD value. One possible intervention is treating patients with diabetes mellitus (DM). Patients diagnosed with DM require therapy to regulate blood sugar levels, and it must be administered throughout their lives. Adherence to therapy is crucial for achieving optimal clinical outcomes and improving quality of life. As with other studies, adherence to prescribed therapy is crucial not only for achieving optimal clinical outcomes, but also for determining patients quality of life. Adherence to therapeutic regimens has been shown to substantially improve patients quality of life. This improvement is primarily due to improved disease control and reduced complications [13].

Healthcare professionals play a pivotal role in promoting patient compliance with treatment regimens [14]. Patient education is one of the most effective strategies which aims to enhance comprehension of the condition and the significance of adhering to treatment [15]. Such educational interventions generally consist of counseling sessions and the provision of printed or digital information on disease management. By increasing patient knowledge and motivation, this intervention can improve adherence to therapy [13]. These various methods will undoubtedly have a positive impact on reducing the YLD value in both provinces so that patients do not experience a life of disability due to increasing complications.

The increasing trend in DALY values in Figure 3 confirms that DM, as a non-communicable disease, contributes significantly to the loss of productive years of life in Central Java and Yogyakarta. The presence of DM has been demonstrated to be associated with a heightened risk of both chronic morbidity and premature mortality. Therefore, comprehensive measures need to be taken to reduce the burden of DM in both provinces, not only in terms of complications that cause disability but also premature death that can be caused by the disease.

The increase in the burden of DM in Yogyakarta, as indicated by the continuous increase in DALY in the province, shows a discrepancy with life expectancy data. Based on data from Statistics Indonesia, the life expectancy for men and women in Yogyakarta is 73.6 years and 77.4 years, respectively. When compared to life expectancy figures in Central Java, these values are higher because life expectancy for both men and women in Central Java is 73.21 years and 76.99 years, respectively. Therefore, it can be concluded that the population in Yogyakarta has a longer life expectancy than the population in Central Java.

Although life expectancy in Yogyakarta is relatively high, this province has a high DALY value because the people of Yogyakarta have a higher health burden due to diabetes cases than the people of Central Java. This phenomenon is explained by the impact of population ageing, where more elderly people are vulnerable to diabetes and its complications, as well as by the phenomenon of '*expansion of morbidity*', where increased life expectancy is not always accompanied by an increase in the number of healthy years of life [16]. Additionally, improvements in detection and medical services can reduce premature mortality (increasing *life expectancy*) but simultaneously increase the prevalence of chronic diseases managed throughout life, thereby increasing the YLD value. Therefore, high *life expectancy* and high DALY are not an absolute contradiction, but rather a reflection of the interaction between demographics, epidemiology, and the capacity of the health system at the provincial level [17].

▪ CONCLUSION

The DALY and its components showed an overall increasing trend in both provinces. Yogyakarta had a higher disease burden than Central Java, with an average DALY rate of 1062.48 compared with 807.01. In both provinces, YLL contributed more to the total DALY than YLD, indicating that premature mortality remains the main driver of the disease burden of DM. Future studies should identify the determinants of high YLL among patients with DM to support evidence-based interventions. Policies aimed at reducing premature deaths, such as expanding early diabetes screening programs, should be prioritized in both provinces.

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