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THE DIFFERENCES IN METABOLIC SYNDROME PARAMETERS BETWEEN INDIVIDUALS WITH MENTAL HEALTH DISORDERS AND HEALTHY INDIVIDUALS: A COMMUNITY BASED COMPARATIVE STUDY

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Abstract

Objectives: This study aimed to analyze the differences in metabolic health parameter values with mental health disorders (MHD). Methods: a total of 3725 respondents were included in this study. This study used secondary data from the Cohort Study of Non-Communicable Disease Risk Factors collected by interview method on permanent residents in Bogor City, Indonesia in 2018. Respondents with MHD if they experienced at least 6 symptoms out of 20 symptoms in the Self Reporting Questionnaire (SRQ) instrument. Independent variables included fasting blood sugar, post-loading blood sugar, total cholesterol, LDL, HDL, triglycerides, systolic blood pressure, diastolic blood pressure, and body mass index (BMI). Data were analyzed by Mann-Whitney test. Results: Significant differences between individuals with and without mental health disorders were observed in age (p-value=0.037), total cholesterol level (p-value=0.003), triglyceride level (p-value=0.000), LDL level (p-value=0.001), HDL level (p-value=0. 003), body weight (p-value=0.000), height (p-value=0.000), and BMI (p-value=0.050), however, there were no significant differences in fasting blood sugar levels, post-loading blood sugar levels, systolic blood pressure, and diastolic blood pressure. Conclusions: This study found significant differences in several metabolic health parameters between individuals with and without mental health disorders (MDD). Parameters that showed significant differences included age, total cholesterol, triglycerides, LDL, HDL, weight, height, and body mass index (BMI). In contrast, no significant differences were found in fasting blood sugar levels, post-load blood sugar levels, systolic blood pressure, and diastolic blood pressure.

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Introduction

The prevalence of mental health problems in Bogor City, Indonesia, is a cause for concern. According to a study, the prevalence of mental or emotional problems in the population in West Java, including Bogor City, is 12.1% in individuals aged 15 years and above (Pandia et al., 2021). Major Depressive Disorder (MDD) first episode was found to be significantly associated with changes in cholesterol and triglyceride levels. A meta-analysis of case-control studies revealed that first-episode MDD is associated with increased triglyceride levels and lower high-density lipoprotein (HDL) cholesterol levels (Wei et al., 2020). Individuals with MHD often experience unhealthy diets, low physical activity, and smoking or alcohol consumption habits, which contribute to the development of metabolic disorders. Pharmacological treatments, such as the use of antipsychotics and antidepressants, also play a significant role in increasing the risk of obesity, dyslipidemia, and insulin resistance. Therefore, understanding the relationship between mental and metabolic health is important for designing better prevention strategies (Prabawa et al., 2019). In addition, cross-sectional studies show an association between depression and total cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides, and HDL cholesterol levels (Han, 2022). These findings suggest that lipid profile disturbances, including increased triglycerides and decreased HDL cholesterol, may be present in individuals experiencing a first episode of MDD.

A recent study by Yu et al (2021) in China that serum lipid concentrations are associated with negative mental health outcomes in healthy women aged 35-49 years. The study investigated the impact of metabolic function on mental health outcome relationships by assessing psychosocial stress in healthy women aged 25-65 years. The results showed that poor mental health was significantly associated with increased BMI, total cholesterol, LDL cholesterol, and triglyceride levels (Yu et al., 2021).

Studies on the relationship between mental health problems and various socio-demographic factors such as gender, education, household size, residence, occupation, and income have been conducted (Aye et al., 2020; Chen et al., 2020; Cook et al., 2021; Irmansyah et al., 2009; Jin et al., 2020; Pandia et al., 2021; Subramaniam et al., 2020; Susanti et al., 2024), However, there is little discussion on the relationship between mental health and metabolic syndrome parameters. This study is needed to explore the association of metabolic health parameters with mental health disorders.

Methods

This study is a secondary data analysis that uses research data from the 2018 Cohort Study of Risk Factors for Non-Communicable Diseases in Bogor City from the Ministry of Health of the Republic of Indonesia and is a community-based prospective cohort study.

A total of 3,725 respondents were enrolled in the 2018 cohort study and data were collected using a total sampling technique. Mental health disorder status was determined by the WHO Self-Report Questionnaire-20 (SRQ-20), which was obtained from the Non-Communicable Disease Risk Factor Cohort Study data. The SRQ-20 is a tool used to measure common symptoms of mental disorders. The SRQ-20 consists of 20 questions regarding the prevalence of somatic, cognitive, and emotional symptoms over the past 30 days: 0 = No and 1 = Yes. Referring to previous studies that validated the SRQ-20 in the Indonesian population. The study determined MHD with a cut-off point $\geq$ 6, positive predictive value = 70%, and negative predictive value = 92% (Azam et al., 2021; Ganihartono, 1996; Irmansyah et al., 2010; Reuter et al., 2020).

Data were presented in frequencies and percentages based on variable categories. Mann-Whitney Test analysis was conducted to determine the differences in risk factors for metabolic syndrome between respondents with and without mental health disorders. All analyses were performed by SPSS 22.0 (IBM Corporation, NY, USA).

This cohort data source has obtained ethical approval which is renewed annually from the Health Research Ethics Commission, Agency for Health Research and Development, Ministry of Health of the Republic of Indonesia. The ethical clearance for the study in 2017 was number LB.02.01/5.2/KE.108/ 2017. No further ethical clearance was required for the analysis of secondary data.

Results

Table 1. Characteristics of Study Respondents (n: 3725)

Characteristic	Frequency	Percent
Gender		
Male	1136	30.5
Female	2589	69.5
Education Level		
No Schooling	48	1.3
Did Not Complete Elementary	443	11.9
Completed Elementary	888	23.8
Completed Middle School	812	21.8
Completed High School	1302	35
Completed College	232	6.2
Employment Status		
Employed	3600	96.6
Unemployed	125	3.4
Health Insurance Ownership		
Yes	1447	38.8
No	2278	61.2
Smoking History		
Ever Smoked	1831	49.2
Never Smoked	1894	50.8
Alcohol Consumption History		
Ever Consumed Alcohol	650	17.4
Never Consumed Alcohol	3075	82.6
Mental Health Disorders		
Yes	1590	42.7
No	2135	57.3

Sources: Authors

Table 1 shows that the majority of respondents were female (69.5%), had a high school education (35.0%), and were employed (96.6%). In addition, more than half of the respondents did not have health insurance (61.2%) and never smoked (50.8%) or consumed alcohol (82.6%). Most respondents also did not have mental health problems (57.3%).

Table 2. Measures of Centering and Measures of Spread of Variables (n: 3725)

Variable	p-value	Mean	SD
Age (years)	p<0.001	44.2	10
Fasting Blood Glucose Level (mg/dL)	p<0.001	89.2	26.2
Post-load Blood Glucose Level (mg/dL)	p<0.001	129.2	54.5
Total Cholesterol Level (mg/dL)	p<0.001	203.6	37.9
Triglyceride Level (mg/dL)	p<0.001	112.7	69.6
LDL Level (mg/dL)	p<0.001	129.6	32.5
HDL Level (mg/dL)	p<0.001	50.9	11
Body Weight (kg)	p<0.001	58.6	11.3
Height (cm)	p<0.001	153.3	7.7
BMI	p<0.001	25	4.6
Systolic Blood Pressure (mmHg)	p<0.001	131.1	26.3
Diastolic Blood Pressure (mmHg)	p<0.001	82.5	14.1

Table 2 shows that all the variables in the table showed abnormal distribution (p<0.001). The data showed significant variation in the health parameters of the respondents, with the greatest variation seen in triglyceride levels and post-loading blood sugar levels, and the least variation in HDL levels. Centering measures such as mean, median and mode provide an overview of the distribution of

the data, while dispersion measures such as standard deviation and variance show how far the data are scattered from the mean.

Table 3. Differences in Metabolic Syndrome Parameters in Individuals with Mental Health Status

Parameter	MHD: Yes			MHD: No			p-value
	Mean	Median	SD	Mean	Median	SD	
Age (years)	43,8	44	10,2	44,5	45	9,9	0,037
Fasting Blood Glucose (mg/dL)	89,3	84	28,3	89,1	85	24,4	0,29
Post-load Blood Glucose (mg/dL)	128,5	117	55,9	129,7	118	53,5	0,239
Total Cholesterol (mg/dL)	201,8	199	38,7	204,9	202	37,2	0,003
Triglyceride (mg/dL)	109,3	93	71,2	115,3	98	68,2	0,000
LDL (mg/dL)	127,8	126	33,4	130,8	129	31,8	0,001
HDL (mg/dL)	51,5	51	11	50,5	50	10,9	0,003
Body Weight (kg)	57,4	56,4	11,2	59,5	58,3	11,3	0,000
Height (cm)	152,2	151	7,1	154,1	153	7,9	0,000
BMI	24,8	24,4	4,8	25,1	24,9	4,5	0,050
Systolic Blood Pressure (mmHg)	130,7	124	27	131,4	126	25,7	0,087
Diastolic Blood Pressure (mmHg)	82,7	81	14,3	82,3	81	14	0,519

*p-value<0.05; p-value<0.001; *Sources: Authors*

Table 3 shows the differences in metabolic syndrome parameters in individuals with and without mental health disorders. The data shown includes the mean, median, standard deviation (SD), and p-value for each parameter. The mean age of individuals with mental health disorders was 43.8 years, while individuals without mental health disorders had a mean age of 44.5 years. The median ages for both groups were 44.0 and 45.0 years respectively, with standard deviations of 10.2 and 9.9. A p value of 0.037 indicated a significant difference between the two groups.

The mean fasting blood sugar level in individuals with mental health disorders was 89.3 mg/dL, while in individuals without mental health disorders it was 89.1 mg/dL. The medians for both groups were 84.0 and 85.0 mg/dL with standard deviations of 28.3 and 24.4. A p value of 0.290 indicated no significant difference between the two groups. The mean post-loading blood sugar level in individuals with mental health disorders was 128.5 mg/dL, while in individuals without mental health disorders it was 129.7 mg/dL. The medians for both groups were 117.0 and 118.0 mg/dL with standard deviations of 55.9 and 53.5. The p value of 0.239 indicated no significant difference between the two groups.

The mean total cholesterol level in individuals with mental health disorders was 201.8 mg/dL, while in individuals without mental health disorders it was 204.9 mg/dL. The medians for both groups were 199.0 and 202.0 mg/dL with standard deviations of 38.7 and 37.2. A p value of 0.003 indicated a significant difference between the two groups. The mean triglyceride level in individuals with mental health disorders was 109.3 mg/dL, while in individuals without mental health disorders it was 115.3 mg/dL. The medians for both groups were 93.0 and 98.0 mg/dL with standard deviations of 71.2 and 68.2. A p value of 0.000 indicated a highly significant difference between the two groups.

The mean LDL level in individuals with mental health disorders was 127.8 mg/dL, while in individuals without mental health disorders it was 130.8 mg/dL. The medians for both groups were 126.0 and 129.0 mg/dL with standard deviations of 33.4 and 31.8. A p value of 0.001 indicated a highly significant difference between the two groups. The mean HDL level in individuals with mental health

disorders was 51.5 mg/dL, while in individuals without mental health disorders it was 50.5 mg/dL. The medians for both groups were 51.0 and 50.0 mg/dL with standard deviations of 11.0 and 10.9. A p value of 0.003 indicated a significant difference between the two groups.

The mean body weight of individuals with mental health disorders was 57.4 kg, while that of individuals without mental health disorders was 59.5 kg. The medians for both groups were 56.4 and 58.3 kg with standard deviations of 11.2 and 11.3. A p value of 0.000 indicated a highly significant difference between the two groups. The mean height of individuals with mental health disorders was 152.2 cm, while that of individuals without mental health disorders was 154.1 cm. The medians for both groups were 151.0 and 153.0 cm with standard deviations of 7.1 and 7.9. A p value of 0.000 indicated a highly significant difference between the two groups.

The mean BMI of individuals with mental health disorders was 24.8, while that of individuals without mental health disorders was 25.1. The medians for both groups were 24.4 and 24.9 with standard deviations of 4.8 and 4.5. A p value of 0.050 indicated a significant difference between the two groups. The mean systolic blood pressure in individuals with mental health disorders was 130.7 mmHg, while that in individuals without mental health disorders was 131.4 mmHg. The medians for both groups were 124.0 and 126.0 mmHg with standard deviations of 27.0 and 25.7. The p value of 0.087 indicated no significant difference between the two groups. The mean diastolic blood pressure in individuals with mental health disorders was 82.7 mmHg, while in individuals without mental health disorders it was 82.3 mmHg. The median for both groups was 81.0 with a standard deviation of 14.3 and 14.0. A p value of 0.519 indicated no significant difference between the two groups.

Overall, some parameters of metabolic syndrome showed significant differences between individuals with and without mental health disorders, especially in age, total cholesterol, triglycerides, LDL, HDL, weight, height, and BMI. Other parameters did not show significant differences.

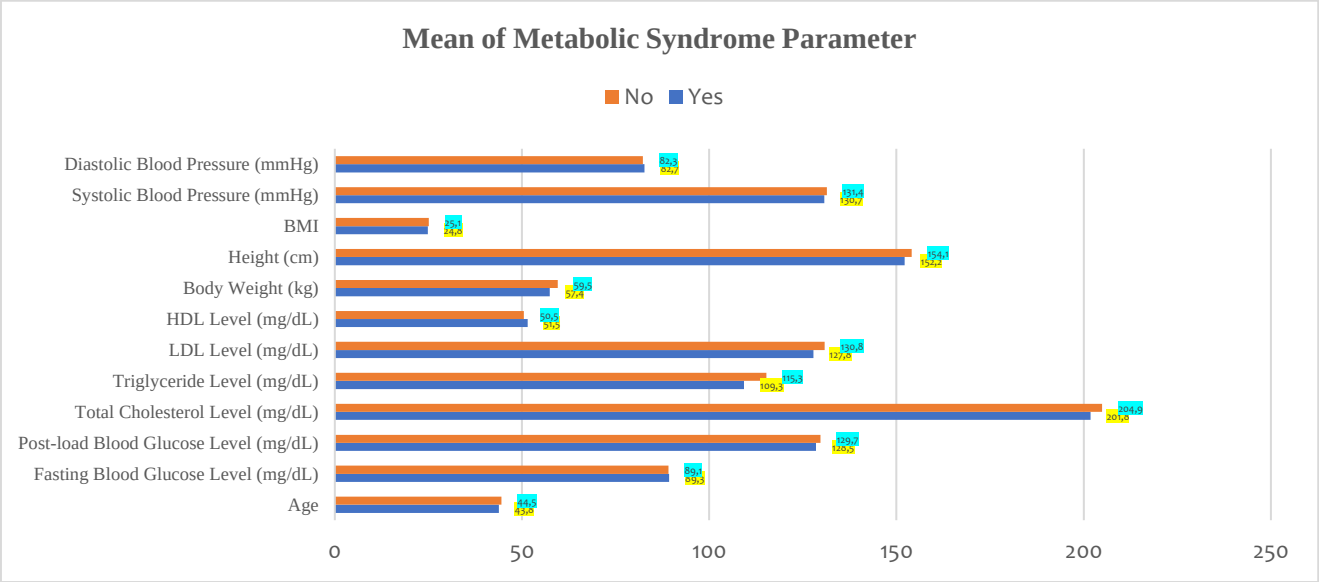

Figure 1. Difference in mean values of Metabolic Syndrome Parameters in Individuals with MHD Status

Discussion

This study highlights significant differences in certain parameters of metabolic syndrome between individuals with and without mental health disorders. These parameters include age, total cholesterol level, triglyceride level, LDL level, HDL level, weight, height, and BMI. Individuals with mental health disorders (MHD) are at higher risk for metabolic disorders compared to the general population. This may be explained by several mechanisms, including hormonal and inflammatory changes triggered by chronic stress from mental disorders. Mental disorders

such as depression and anxiety are known to increase levels of stress hormones, such as cortisol, which can affect lipid, glucose, and body weight metabolism. In addition, individuals with MHD often experience unhealthy diets, low physical activity, and smoking or alcohol consumption, which contribute to the development of metabolic disorders (Mariotti, 2015).

Age was found to be a significant parameter, with individuals with mental health disorders tending to be younger. MHD often appear at a younger age, with one-third of first mental disorders occurring before the age of 14, and half before the age of 18 (Solmi et al., 2022). This is in line with previous studies suggesting that young individuals with mental health disorders may be at higher risk of developing metabolic syndrome due to factors such as poor diet, lack of exercise, and side effects of psychiatric medication (Holt & Peveler, 2011; Newcomer, 2007). Age-related changes in metabolism and lifestyle behaviors further complicate this relationship, emphasizing the need for age-specific interventions in managing metabolic syndrome among those with mental health conditions.

A study was conducted in Brazil to determine the prevalence of metabolic syndrome and psychiatric disorders. The study involved 1,023 young adult respondents with an average age of 25 years. The population-based study found that 24.3% of the respondents suffered from metabolic disorders. Of the total 24.3% of respondents identified, they were diagnosed with anxiety disorders, depression, bipolar disorder, and suicide risk. This shows the possibility that young adults have a malnourished and sedentary lifestyle, making this age group have a high prevalence of metabolic syndrome (Moreira et al., 2018).

Different research results were obtained by Hildrum et al. The study involved 10,206 respondents from the age range of 18 to 89 years. The study shows that the prevalence of metabolic syndrome will increase as a person ages. The prevalence of Metabolic Syndrome in men aged 20-29 years is 11%. The figure increased to 47.2% in men aged 80-89 years. The prevalence of metabolic syndrome in women aged 20-29 years was 9.2%. The figure increased to 64.4% in the age range of 18-89 years. This is due to physiological and environmental changes that affect nutritional and metabolic conditions when they are older, thus increasing cardiovascular disease (Hildrum et al., 2007).

Significant differences in lipid profiles (total cholesterol, triglycerides, LDL, and HDL levels) suggest a strong link between dyslipidemia and mental health disorders. Elevated cholesterol and triglyceride levels have been associated with depression and anxiety (Association, 2017; Lee & Siddiqui, 2019). Stress-related hormones, such as cortisol, can affect lipid metabolism, thus leading to dyslipidemia in individuals with mental health problems. In addition, the use of psychotropic medications, particularly antipsychotics and antidepressants, has been shown to adversely affect lipid profiles (Bhuvaneswar et al., 2009; Romanova et al., 2022).

A cross sectional study was conducted in India to assess the association of HDL and LDL with depression severity. The study involved 200 respondents aged 18-65 years who were diagnosed with depression. The majority of respondents in this study had moderate to severe depression. The results showed a negative correlation between depression and HDL cholesterol. This is due to the protective effect of HDL cholesterol against depression. Other studies have also shown an inverse relationship between depression and HDL levels (Shaker et al., 2021). However, there is a positive correlation between increased LDL cholesterol levels and the presence of cognitive depression in patients (Poorva Gupta, 2021). In addition, another study found that patients with severe depressive disorders had higher serum LDL levels.

The severity of one's depression is associated with high lipid content in one's body (Wagner et al., 2019). Poorva, et al's study showed that high lipid levels were found in the majority of male and female participants diagnosed with depression. Jia *et al.,* revealed that there were high HDL levels in patients with depression (Jia et al., 2020). Kim J *et al.,* stated that LDL levels are associated with the risk of depression especially in men. This is due to the possibility that men have high cholesterol levels compared to women. In addition, men have different stressors and the use of additional substances (Kim et al., 2019).

Significant differences in weight, height, and BMI between the two groups further emphasized the physical health disparities faced by individuals with mental health disorders. The higher BMI in these individuals may be due to factors such as medication-induced weight gain, reduced physical activity, and poor eating habits (Li et al., 2022; Maguen et al., 2013;

McLaren et al., 2008). These findings are consistent with the wider literature linking obesity and mental health disorders, which suggests a bidirectional relationship where each condition exacerbates the other (Li et al., 2022).

A study was conducted in the USA on the relationship between Body Mass Index and depression/depressive symptoms. The study showed a positive relationship between BMI and depressive symptoms. The study showed that obese men had a higher prevalence of depression compared to women. Men and women who are obese have a higher precession of depression or experience depressive symptoms compared to men and women who have normal weight (Badillo et al., 2022).

Other studies have found no inverse relationship between obesity and depression in non-Hispanic black women and Mexican American women. Men are more likely to develop obesity and depression as they age. Another study also evaluated the relationship between depression and obesity with diabetes as a covariable. The study found that factors associated with depression were obesity, younger age, female gender and having diabetes (Hawkins et al., 2018).

Interestingly, fasting blood glucose levels, postprandial blood glucose levels, systolic blood pressure, and diastolic blood pressure did not show significant differences between groups. This suggests that although some aspects of metabolic syndrome are clearly influenced by mental health status, other aspects may be more influenced by factors such as genetic predisposition or long-term lifestyle choices that are not directly influenced by mental health status (Li et al., 2022). The lack of significant differences in blood glucose levels may also suggest that insulin resistance or diabetes is not as prevalent in this sample, or it may reflect the ongoing effectiveness of treatment in managing these parameters in both groups.

Conclusions and Recommendations

In conclusion, this study underscores significant differences in certain metabolic syndrome parameters between individuals with and without mental health disorders. Regular health screenings are essential to monitor lipid profiles, glucose levels, and BMI for early detection of metabolic abnormalities. Lifestyle modifications should also be encouraged, such as adopting a balanced diet rich in fruits, vegetables, whole grains, and healthy fats, along with promoting regular physical activity tailored to individual capabilities. Stress management programs, including mindfulness, counseling, and therapy, are crucial to addressing chronic stress, which can exacerbate metabolic issues.

Additionally, medication management is necessary to monitor and mitigate the metabolic side effects of psychotropic medications, such as antipsychotics and antidepressants. Where possible, alternative medications with fewer adverse metabolic effects should be considered. Patients should also be educated on the negative impacts of smoking and alcohol on metabolic health and supported in cessation efforts.

References

Association, A. H. (2017). HDL (good), LDL (bad) cholesterol and triglycerides. *American Heart Association*.

Aye, W. T., Lien, L., Stigum, H., Win, H. H., Oo, T., & Bjertness, E. (2020). The prevalence of mental distress and the association with education: a cross-sectional study of 18-49-year-old citizens of Yangon Region, Myanmar. *BMC Public Health, 20*, 1–12.

Azam, M., Sulistiana, R., Fibriana, A. I., Savitri, S., & Aljunid, S. M. (2021). Prevalence of Mental Health Disorders among Elderly Diabetics and Associated Risk Factors in Indonesia. *International Journal of Environmental Research and Public Health*, *18*(19). https://doi.org/10.3390/ijerph181910301

Badillo, N., Khatib, M., Kahar, P., & Khanna, D. (2022). Correlation between body mass index and depression/depression-like symptoms among different genders and races. *Cureus*, *14*(2).

Bhuvaneswar, C. G., Baldessarini, R. J., Harsh, V. L., & Alpert, J. E. (2009). Adverse endocrine and metabolic effects of psychotropic drugs: selective clinical review. *CNS Drugs, 23*, 1003–1021.

Chen, X., Wang, S.-B., Li, X.-L., Huang, Z.-H., Tan, W.-Y., Lin, H.-C., Hou, C.-L., & Jia, F.-J. (2020). Relationship between sleep duration and sociodemographic characteristics, mental health and chronic diseases in individuals aged from 18 to 85 years old in Guangdong province in China: a population-based cross-sectional study. *BMC Psychiatry*, *20*(1), 1–10.

Cook, S., Saburova, L., Bobrova, N., Avdeeva, E.,

Malyutina, S., Kudryavtsev, A. V, & Leon, D. A. (2021). Socio-demographic, behavioural and psycho-social factors associated with depression in two Russian cities. *Journal of Affective Disorders*, *290*, 202–210.

Ganihartono, I. (1996). Psychiatric morbidity among patients attending the Bangetayu community health centre in Indonesia. *Buletin Penelitian Kesehatan*, *24*(4).

Han, A. L. (2022). Association between lipid ratio and depression: a cross-sectional study. *Scientific Reports*, *12*(1), 6190. https://doi.org/10.1038/s41598-022-10350-5

Hawkins, J., Watkins, D., Allen, J. O., & Mitchell, J. (2018). Identifying subgroups of Black, Hispanic and Asian men at increased risk for comorbid depression and overweight or obesity. *Preventive Medicine Reports*, *12*, 268–270.

Hildrum, B., Mykletun, A., Hole, T., Midthjell, K., & Dahl, A. A. (2007). Age-specific prevalence of the metabolic syndrome defined by the International Diabetes Federation and the National Cholesterol Education Program: the Norwegian HUNT 2 study. *BMC Public Health*, *7*, 1–9.

Holt, R. I. G., & Peveler, R. C. (2011). Metabolic Syndrome and Mental Illness. *The Metabolic Syndrome*, 177–193.

Irmansyah, I., Dharmono, S., Maramis, A., & Minas, H. (2010). Determinants of psychological morbidity in survivors of the earthquake and tsunami in Aceh and Nias. *International Journal of Mental Health Systems*, *4*, 1–10.

Irmansyah, I., Prasetyo, Y. A., & Minas, H. (2009). Human rights of persons with mental illness in Indonesia: more than legislation is needed. *International Journal of Mental Health Systems*, *3*(1), 14. https://doi.org/10.1186/1752-4458-3-14

Jia, Q., Yang, H., Zhuang, N., Yin, X., Zhu, Z., Yuan, Y., Yin, X., Wang, Y., Cheung, E. F. C., & Chan, R. C. K. (2020). The role of lipoprotein profile in depression and cognitive performance: a network analysis. *Scientific Reports*, *10*(1), 20704.

Jin, Y., Zhang, Y.-S., Zhang, Q., Rao, W.-W., Zhang, L.-L., Cui, L.-J., Li, J.-F., Li, L., Ungvari, G. S., & Jackson, T. (2020). Prevalence and socio-demographic correlates of poor mental health among older adults in agricultural areas of China. *Frontiers in Psychiatry*, *11*, 549148.

Kim, E. J., Hong, J., & Hwang, J.-W. (2019). The association between depressive mood and cholesterol levels in Korean adolescents. *Psychiatry Investigation*, *16*(10), 737.

Lee, Y., & Siddiqui, W. J. (2019). Cholesterol levels. In *StatPearls*.

Li, X., Shi, X., Tan, Y., Yu, Y., Tang, C., Xu, G., Zhang, X., Liao, H., Mai, X., Chen, W., Luo, X., Xu, C., Xie, G., & Liang, J. (2022). Metabolic indexes of obesity in patients with common mental disorders in stable stage. *BMC Psychiatry*, *22*(1), 91. https://doi.org/10.1186/s12888-022-03752-2

Maguen, S., Madden, E., Cohen, B., Bertenthal, D., Neylan, T., Talbot, L., Grunfeld, C., & Seal, K. (2013). The relationship between body mass index and mental health among Iraq and Afghanistan veterans. *Journal of General Internal Medicine*, *28*, 563–570.

Mariotti, A. (2015). The Effects of Chronic Stress On Health: New Insights Into the Molecular Mechanisms of Brain–Body Communication. *Future Science OA*, *1*(3). https://doi.org/10.4155/fso.15.21

McLaren, L., Beck, C. A., Patten, S. B., Fick, G. H., & Adair, C. E. (2008). The relationship between body mass index and mental health: A population-based study of the effects of the definition of mental health. *Social Psychiatry and Psychiatric Epidemiology*, *43*, 63–71.

Moreira, F. P., Jansen, K., Cardoso, T. de A., Mondin, T. C., Magalhaes, P. V, Kapczinski, F., Souza, L. D. M., da Silva, R. A., Oses, J. P., & Wiener, C. D. (2018). Metabolic syndrome and psychiatric disorders: a population-based study. *Brazilian Journal of Psychiatry*, *41*(1), 38–43.

Newcomer, J. W. (2007). Metabolic syndrome and mental illness. *American Journal of Managed Care*, *13*(7), S170.

Pandia, V., Noviandhari, A., Amelia, I., Hidayat, G. H., Fadlyana, E., & Dhamayanti, M. (2021). Association of Mental Health Problems and Socio-Demographic Factors Among Adolescents in Indonesia. *Global Pediatric Health*, *8*, 2333794X211042223. https://doi.org/10.1177/2333794X211042223

Poorva Gupta, K. A. (2021). Correlation of HDL and LDL Cholesterol with Severity of Depression: A Cross-sectional Study. *Journal of Clinical & Diagnostic Research*, *18*(1).

Prabawa, I. P. A. G., Witari, P. K., & Ariawan, I. W.

Y. (2019). Gambaran sindrom metabolik pada pasien gangguan jiwa yang dirawat di rumah sakit jiwa provinsi Bali. *Intisari Sains Medis*, *10*(2), 459–464. https://doi.org/10.15562/ism.v10i2.456

Reuter, A., Vollmer, S., Aiyub, A., Susanti, S. S., & Marthoenis, M. (2020). Mental distress and its association with sociodemographic and economic characteristics: community-based household survey in Aceh, Indonesia. *BJPsych Open*, *6*(6), e134.

Romanova, Z., Hlavacova, N., & Jezova, D. (2022). Psychotropic drug effects on steroid stress hormone release and possible mechanisms involved. *International Journal of Molecular Sciences*, *23*(2), 908.

Shaker, N. M., Sultan, M., Mohamed, M. Y., Helal, S. A., & Abd El Moneam, M. H. E.-D. (2021). Lipid profile and impulsivity in suicidal patients with major depressive disorder. *Archives of Suicide Research*, *25*(3), 641–656.

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., Salazar de Pablo, G., Il Shin, J., Kirkbride, J. B., Jones, P., Kim, J. H., Kim, J. Y., Carvalho, A. F., Seeman, M. V., Correll, C. U., & Fusar-Poli, P. (2022). Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular Psychiatry*, *27*(1), 281–295. https://doi.org/10.1038/s41380-021-01161-7

Subramaniam, M., Abdin, E., Seow, E., Vaingankar, J. A., Shafie, S., Shahwan, S., Lim, M., Fung, D., James, L., & Verma, S. (2020). Prevalence, socio-demographic correlates and associations of adverse childhood experiences with mental illnesses: Results from the Singapore Mental Health Study. *Child Abuse & Neglect*, *103*, 104447.

Susanti, H., Brooks, H., Yulia, I., Windarwati, H. D., Yuliastuti, E., Hasniah, H., & Keliat, B. A. (2024). An exploration of the Indonesian lay mental health workers' (cadres) experiences in performing their roles in community mental health services: a qualitative study. *International Journal of Mental Health Systems*, *18*(1), 3. https://doi.org/10.1186/s13033-024-00622-0

Wagner, C. J., Musenbichler, C., Böhm, L., Färber, K., Fischer, A.-I., von Nippold, F., Winkelmann, M., Richter-Schmidinger, T., Mühle, C., & Kornhuber, J. (2019). LDL cholesterol relates to depression, its severity, and the prospective course. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *92*, 405–411.

Wei, Y.-G., Cai, D.-B., Liu, J., Liu, R.-X., Wang, S.-B., Tang, Y.-Q., Zheng, W., & Wang, F. (2020). Cholesterol and triglyceride levels in first-episode patients with major depressive disorder: A meta-analysis of case-control studies. *Journal of Affective Disorders*, *266*, 465–472. https://doi.org/10.1016/j.jad.2020.01.114

Yu, J., Zhang, Z., Li, C., Zhang, J., Ding, Z., Zhu, W., & Wang, Q. (2021). Serum Lipid Concentrations Are Associated With Negative Mental Health Outcomes in Healthy Women Aged 35-49 Years. *Frontiers in Psychiatry*, *12*, 773338. https://doi.org/10.3389/fpsyt.2021.773338