

Skrining Metabolik Berbasis Masyarakat dan Edukasi Kesehatan Penyakit Tidak Menular di Kabupaten Lamongan, Indonesia

Community-Based Metabolic Screening and Health Education of Non-Communicable Diseases in Lamongan District, Indonesia

M. Ainul Mahbubillah¹, Awaluddin Susanto², Aisyah Hadi Ramadani³, Putri Ayu Ika Setiyowati^{4*}, Rofiatun Solekha⁵, and Muhammad Badrut Tamam⁶

^{1,3,4,5,6}Study Program of Biology, Faculty of Science, Technology, and Education, Universitas Muhammadiyah Lamongan, Lamongan Indonesia, ²Technology of Medical Laboratory Study Program, Institut Teknologi Sains dan Kesehatan Insan Cendekia Medika Jombang, Jombang, 61419, Indonesia, ³Doctoral of Philosophy, Faculty of Environment and Resources Studies, Mahidol University, Phutthamonthon Sai 4 Rd, Salaya, Phutthamonthon District, Nakhon Pathom 73170, Thailand

Email: ¹ainul.mahbubillah@gmail.com, ²awwaluddins@yahoo.com, ³aisyahramadani47@gmail.com, ⁴putriayuikasetiyowati@gmail.com*, ⁵rofiatunsolekha2@gmail.com, ⁶mh.badruttamam@gmail.com

*surel: putriayuikasetiyowati@gmail.com

Abstract

Non-communicable diseases often progress without obvious early symptoms, while routine screening remains difficult to access for many community members. This community service activity combined blood glucose and uric acid screening with individual result communication and practical risk-reduction education in a public space. The program was conducted at Lamongan Square on 18 January 2026 and involved 50 adult participants who joined voluntarily. Capillary blood was tested with a portable multi-parameter meter, and each participant received a written result card, a brief explanation, and follow-up advice. Among the 50 participants (28 women and 22 men), high-category random blood glucose was identified in 5 participants (10.0%), while 46 participants (92.0%) had uric acid readings within the normal-range category. These point-of-care measurements were used as initial screening and were not intended to establish a clinical diagnosis. Participants with results requiring attention were advised to obtain repeat or confirmatory assessment at an appropriate healthcare facility. The activity demonstrates a feasible model for linking public-space screening, understandable education, and referral advice.

Keywords: community screening; non-communicable diseases; health education; risk awareness

Abstrak

Penyakit tidak menular sering berkembang tanpa menunjukkan gejala awal yang jelas, sementara akses terhadap pemeriksaan kesehatan rutin masih sulit dijangkau oleh banyak anggota masyarakat. Kegiatan pengabdian kepada masyarakat ini mengombinasikan pemeriksaan kadar glukosa darah dan asam urat dengan penyampaian hasil secara individual serta edukasi praktis mengenai pengurangan faktor risiko di ruang publik. Program dilaksanakan di Alun-Alun Lamongan pada 18 Januari 2026 dan melibatkan 50 peserta dewasa yang berpartisipasi secara sukarela. Darah kapiler diperiksa menggunakan alat ukur portabel multiparameter, dan setiap peserta menerima kartu hasil tertulis, penjelasan singkat, serta saran tindak lanjut. Dari 50 peserta (28 perempuan dan 22 laki-laki), hasil glukosa darah sewaktu kategori tinggi ditemukan pada 5 peserta (10,0%), sedangkan 46 peserta (92,0%) memiliki hasil asam urat dalam kategori normal. Pemeriksaan point-of-care ini digunakan sebagai skrining awal dan tidak dimaksudkan untuk menetapkan diagnosis klinis. Peserta dengan hasil yang memerlukan perhatian dianjurkan menjalani pemeriksaan ulang atau konfirmasi di fasilitas pelayanan kesehatan yang sesuai. Kegiatan ini menunjukkan model yang layak diterapkan untuk mengintegrasikan pemeriksaan kesehatan di ruang publik, edukasi yang mudah dipahami, dan pemberian saran rujukan.

Kata kunci: skrining kesehatan masyarakat; penyakit tidak menular; edukasi kesehatan; kesadaran risiko

Introduction

Non-communicable diseases (NCDs) develop over time, are strongly influenced by behavioural and metabolic risks, and may remain undetected until complications occur (Budreviciute et al., 2020; Kang et al., 2021; Kibret et al., 2023). In Indonesia, modifiable risk factors such as smoking, insufficient physical activity, unhealthy dietary patterns, excess body weight, elevated blood pressure, and abnormal glucose metabolism contribute substantially to the NCD burden (Arifin et al., 2022; Simbolon et al., 2020; Bays et al., 2021). NCD multimorbidity also increases health-service use, household expenditure, and productivity loss (Marthias et al., 2021). Environmental toxicant exposure has additionally been reported to produce measurable biological effects in experimental models (Setiyowati, 2020). These findings reinforce the importance of preventive contact and early screening before symptoms become clinically apparent, consistent with the World Health Organization's emphasis on detection, screening, and treatment as core elements of NCD control (World Health Organization, 2025).

Blood glucose and uric acid testing are practical entry points for brief metabolic screening in community settings. Diabetes may remain undiagnosed until complications develop, and sex-related differences in diabetes and its complications have been described (International Diabetes Federation, 2025; Ciarambino et al., 2022). Uric acid is also relevant to metabolic health because elevated values have been associated with obesity, purine metabolism, inflammation, cardiovascular and renal risk, and ischaemic stroke (Huang et al., 2021; Kimura et al., 2021; Padda et al., 2021; Yazdi et al., 2022). However, a single point-of-care value for either glucose or uric acid should be interpreted as a screening signal rather than a stand-alone diagnosis. Clear explanation and appropriate follow-up advice are therefore essential components of the encounter.

Community-based screening can reduce the practical distance between preventive services and the public. In Indonesia, community NCD screening still faces challenges related to access, staffing, equipment, understandable health information, and linkage to care (Widyaningsih et al., 2025). Bringing screening to places where people already gather may therefore create an accessible first contact, provided that testing is accompanied by concise counselling and clear next-step advice.

Lamongan Square was selected because it is a familiar public space used for recreation, exercise, family activities, and informal social interaction. It offers access to adults who may not be actively seeking healthcare and allows a brief, voluntary preventive encounter outside a clinical setting. At the same time, screening in an open public space requires clear communication, respect for privacy, and careful avoidance of diagnostic claims that exceed the scope of the activity. These considerations made Lamongan Square a relevant setting for testing a simple community-service model that combines screening, education, and referral advice.

The program also sought to strengthen the educational component of screening. Individual counselling messages were consolidated into a one-page poster, and a short teach-back checklist was prepared to assess whether participants understood that screening is not a diagnosis, recognised modifiable risk factors, and knew the appropriate follow-up action. This distinction is important because completing a test and receiving information are implementation outputs, whereas participant understanding requires separate evaluation.

Accordingly, this activity aimed to provide accessible random blood glucose and uric acid screening for adult visitors at Lamongan Square; communicate individual results in plain language;

provide brief education on modifiable risk factors; and direct participants with concerning readings toward repeat or confirmatory assessment at an appropriate healthcare facility. The program also sought to identify operational lessons for a more structured and repeatable community screening model.

Implementation Methods

Activity setting and participants

The community service activity was conducted at Lamongan Square, Lamongan Regency, East Java, on 18 January 2026. It was organised by the Biology Study Program, Universitas Muhammadiyah Lamongan, and the Medical Laboratory Technology Study Program, Institut Teknologi Sains dan Kesehatan Insan Cendekia Medika Jombang. The square was selected because it is centrally located, familiar to residents, and frequently visited by adults from different age groups. Recruitment used an open, walk-in approach.

Eligible participants were visitors aged 20 years or older who voluntarily agreed to a finger-prick examination and provided informed consent. Fifty participants completed the activity. Because the program was designed as a community service rather than a prevalence survey, no probability sampling was performed and the findings describe only the participants who attended.

Preparation and team organisation

Preparation included team coordination, role allocation, checking the portable meter and test strips, preparing capillary blood-sampling supplies, and printing consent forms and individual result cards.

The activity followed five consecutive steps: reception and consent, capillary blood testing, result recording, brief individual counselling, and follow-up advice (Table 1). Team members were assigned to each step to keep participant flow consistent. Throughout the activity, results were communicated as screening findings only; no diagnosis was established and no medication was prescribed or changed on the basis of a field reading.

Table 1. Sequence of the community service activity and immediate outputs

Stage	Main activity	Purpose	Immediate output
1	Reception and consent	Confirm voluntary participation and record basic characteristics	Registered participant and signed consent
2	Capillary blood testing	Obtain random blood glucose and uric acid readings	Two point-of-care results
3	Result recording	Create a personal record and reduce transcription loss	Completed individual control card
4	Brief counselling	Explain the meaning and limits of the readings	Participant-specific education
5	Follow-up advice	Identify the appropriate next action	Maintenance advice, repeat testing, or referral recommendation

Screening procedure

After registration, the team explained the purpose of the activity and the nature of the finger-prick procedure. Participants who agreed continued to testing. Capillary blood was collected from a fingertip after skin preparation and applied to the appropriate disposable strip. A portable EasyTouch multi-parameter meter was used to obtain random blood glucose and uric acid readings. The values were copied to the individual control card and the activity recap.

The field recap grouped random blood glucose results into normal-range, intermediate, and high categories, and uric acid results into normal-range and high categories. These were operational categories used for immediate communication during the activity. They were not treated as diagnostic classifications. Because the archived recap did not retain meal timing, symptoms, medication use, or confirmatory laboratory results for every participant, the manuscript reports the recorded categories without making a clinical diagnosis.

Health education, educational media, and referral advice

Education was delivered individually after the result card had been completed. Each participant received the written result and a brief individual explanation. Participants with normal-range results were encouraged to maintain balanced eating, regular physical activity, adequate hydration, and periodic health checks. Those with intermediate or high glucose readings were advised to obtain repeat or confirmatory testing at a healthcare facility, particularly when symptoms or a previous history of abnormal glucose were present. Participants with high uric acid readings received advice on hydration, moderation of high-purine foods, and clinical review when symptoms or relevant medical conditions were present.

Counselling emphasized that a single screening value does not establish a diagnosis. The team focused on one or two practical actions and a clear next step rather than providing a full dietary or treatment plan. The main counselling messages were subsequently consolidated into a one-page educational poster for use in repeated outreach activities.

Evaluation of participant understanding

The educational component was evaluated at two levels. First, implementation coverage was assessed through observable process indicators: completion of both tests, provision of an individual result card, delivery of a participant-specific explanation, and provision of follow-up advice. Second, a five-item interviewer-administered teach-back checklist was designed to measure comprehension. The items assess whether a participant understands that screening is not a diagnosis, can name one relevant metabolic risk factor, can identify one practical risk-reduction action, knows where or when to seek repeat assessment, and can state the next step after an elevated result. Each adequate response receives one point. Scores of 4-5 indicate adequate understanding, 2-3 partial understanding, and 0-1 limited understanding. In the January 2026 record, only implementation-level indicators could be verified; completed teach-back forms were not available, so participant comprehension was not quantified.

Data handling and evaluation

A descriptive evaluation was conducted to assess the implementation of the program. The numerical findings were calculated from the archived activity counts, and percentages for glucose and uric acid categories were calculated within sex using 22 men and 28 women as the respective

denominators. Completed teach-back forms were not included in the archived record; consequently, this manuscript reports verified implementation coverage but does not invent pre-test, post-test, or knowledge-gain values. Descriptive results were used to reflect the service encounter, not to test associations between age, sex, medical history, and biochemical values.

Results and Discussion

Participant reach and profile

Fifty adult visitors completed the screening sequence: 28 women (56%) and 22 men (44%). The largest age group was 41-55 years (29 participants; 58%), followed by >55 years (10 participants; 20%), 31-40 years (7 participants; 14%), and 20-30 years (4 participants; 8%) (Table 2 and Figure 1). These characteristics describe the attendees only and are not intended to represent the wider Lamongan population.

Table 2. Participant profile recorded in the activity recap

Variable	Category	n	%
Sex	Women	28	56
	Men	22	44
Age group	20-30 years	4	8
	31-40 years	7	14
	41-55 years	29	58
	>55 years	10	20

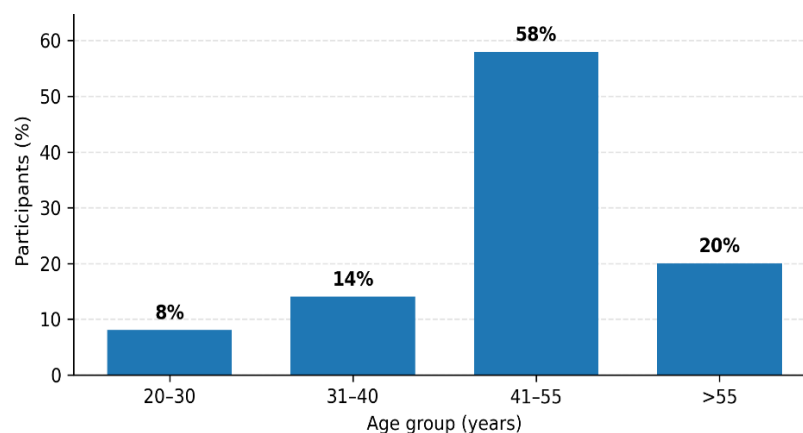


Figure 1. Age distribution reported in the activity recap (n = 50; corrected percentages based on recorded counts).

Random blood glucose screening

The activity recap showed that high-category random blood glucose readings were uncommon. Among men, 12 of 22 (54.5%) were in the normal-range category, 8 (36.4%) in the intermediate category, and 2 (9.1%) in the high category. Among women, 14 of 28 (50.0%) were in the normal-range category, 11 (39.3%) in the intermediate category, and 3 (10.7%) in the high category. Overall, 5 of 50 participants (10.0%) had high-category readings. The combined pattern indicates that most readings fell in the normal-range or intermediate categories.

The intermediate group was not treated as a diagnosis. Participants in the intermediate category were advised to repeat testing under more standardized conditions, whereas those in the high category were advised to seek confirmatory evaluation at a healthcare facility. The

program did not record whether participants subsequently attended a health facility, so linkage to care cannot be quantified.

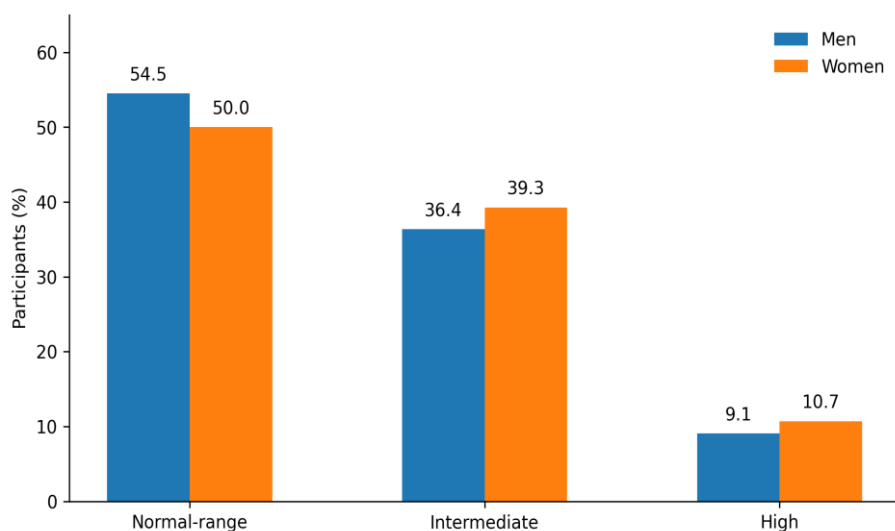


Figure 2. Random blood glucose categories by sex. Percentages were calculated from the recorded counts within each sex.

Uric acid screening

Uric acid screening showed that most recorded results were within the normal-range category. Among men, 20 of 22 (90.9%) were in the normal-range category and 2 (9.1%) were in the high category. Among women, 26 of 28 (92.9%) were in the normal-range category and 2 (7.1%) were in the high category (Figure 3). Overall, 46 of 50 participants (92.0%) had normal-range uric acid readings and 4 (8.0%) had high readings. Participants with high-category results received individual counselling on hydration, dietary moderation, symptoms, and the need for repeat or clinical assessment when appropriate.

Participants with normal-range uric acid results were also reminded that a single screening result reflects one point in time and does not exclude future risk. This message was intended to avoid false reassurance and to reinforce the value of periodic health checks.

Table 3. Screening categories and immediate messages delivered to participants

Finding	Meaning communicated during the activity	Suggested next step
Normal-range glucose	Reading was not elevated within the field category; not a guarantee of lifelong normal glucose	Maintain healthy habits and repeat screening periodically
Intermediate glucose	Reading may be influenced by meal timing and requires clearer assessment	Repeat under standard conditions at a health facility
High glucose	Screening signal that needs timely confirmation; not a field diagnosis	Seek confirmatory testing and clinical assessment
Normal-range uric acid	No elevation recorded at the time of screening	Maintain hydration and balanced intake; reassess if symptoms arise

Finding	Meaning communicated during the activity	Suggested next step
High uric acid	Possible hyperuricaemia requiring context and repeat assessment	Review diet, symptoms, kidney-related conditions, and seek clinical advice

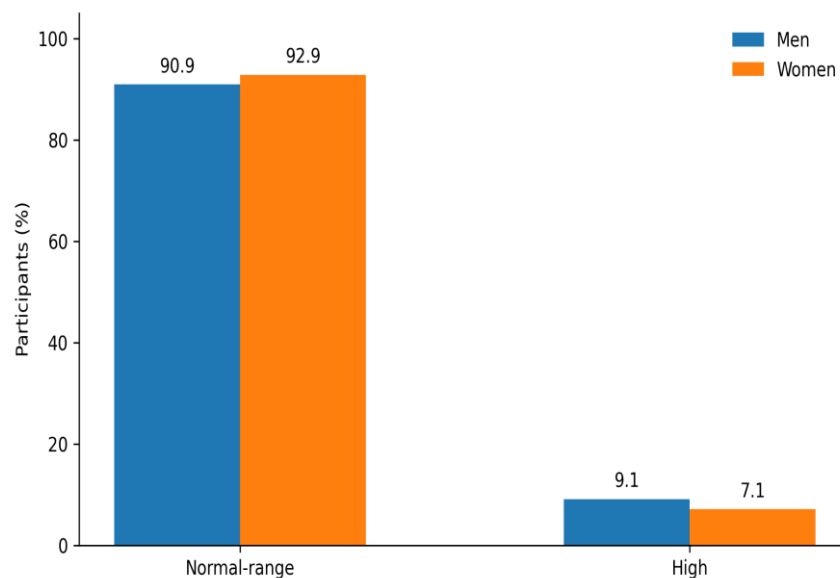


Figure 3. Uric acid categories by sex. Percentages were calculated from the recorded counts within each sex.

Educational and socialization outputs

All 50 participants included in the final recap completed both planned checks, received an individual result card, and received a brief explanation linked to their own screening values. Follow-up advice was provided according to the recorded category. These indicators show complete delivery of the planned service sequence among participants who entered the final recap, although they do not by themselves prove that every message was understood or acted upon.

The activity generated two educational products that make the program more reproducible: a one-page poster that consolidates the main counselling messages and a five-item teach-back checklist for future use. The poster is reproduced in Figure 4.

Table 4. Verified socialization implementation indicators and program products

Indicator	Verified output	Interpretation
Participants completing both point-of-care checks	50 of 50 (100%)	Planned technical service completed
Participants receiving an individual result card	50 of 50 (100%)	Personal result retained for later consultation
Participants receiving an individual explanation	50 of 50 (100%)	Education linked directly to the participant's result
Participants receiving follow-up advice	50 of 50 (100%)	Next-step guidance delivered
Standardized educational poster	1 program product	Supports consistent counselling in later cycles
Five-item teach-back checklist	1 evaluation instrument	Enables future measurement of comprehension



Figure 4. Standardized educational poster developed from the counselling messages delivered during the program.

Overall service delivery

The station completed the planned sequence of registration, testing, recording, explanation, and follow-up advice. Field notes described the activity as running smoothly and receiving a good response from visitors. Its practical strength was immediacy: participants did not need a separate appointment, results were available during the same encounter, and the explanation could be connected to a personal value rather than delivered as a generic message. The health-education component of the activity, in which participants received an explanation and practical information related to early detection of metabolic diseases, is illustrated in Figure 5a. The main documentation weakness was the absence of completed comprehension forms and follow-up records, which prevents a numerical claim about knowledge gain or subsequent use of healthcare

services. At the end of the agenda, all participants took a group photo for documentation purposes (Figure 5b).



Figure 5. (a) Health-education session on the early detection of metabolic diseases during the community outreach activity; (b) Photo session with participants for documentation purposes.

Discussion

The activity demonstrated that a compact metabolic screening station could be implemented in a familiar public space and provide screening and counselling to 50 adults. Conducting the activity at Lamongan Square reduced practical barriers to an initial preventive check and allowed the team to reach individuals who were not necessarily seeking healthcare. However, the walk-in participants cannot be considered representative of the wider Lamongan population. This limitation reflects broader challenges in community-based non-communicable disease (NCD) screening in Indonesia, where accessibility, staffing, equipment, and understandable health information remain important considerations (Widyaningsih et al., 2025). Public-space screening may therefore serve as an accessible first point of contact when linked with appropriate follow-up within the broader NCD prevention pathway (World Health Organization, 2025).

Random blood glucose screening identified 5 of 50 participants (10.0%) in the high category, while intermediate readings occurred in 8 of 22 men (36.4%) and 11 of 28 women (39.3%). These findings indicate that a considerable proportion of participants required further explanation and, where appropriate, repeat assessment. Abnormal glucose metabolism is an important metabolic risk factor for NCDs in Indonesia and is influenced by behavioural and physiological factors (Arifin et al., 2022; Simbolon et al., 2020). The importance of accessible screening is also supported by the fact that diabetes may remain undiagnosed until complications develop (International Diabetes Federation, 2025).

These glucose findings should be interpreted cautiously because meal timing, recent activity, medication use, and confirmatory laboratory testing were not documented for every participant. Therefore, intermediate and high readings cannot be interpreted as diagnoses of prediabetes or diabetes. The categories were used only to guide communication and recommendations for repeat or confirmatory testing. This distinction is important to avoid unnecessary anxiety, inappropriate self-management, or false reassurance. Accordingly, counselling emphasized that the point-of-

care result represented an initial screening signal rather than a definitive diagnosis, consistent with broader NCD prevention strategies that emphasize early detection, risk communication, and appropriate follow-up (Budreviciute et al., 2020).

Uric acid results were predominantly within the normal-range category, with 46 of 50 participants (92.0%) classified as normal and 4 of 50 (8.0%) as high. These values were also interpreted as screening results rather than diagnostic classifications. Hyperuricaemia may be influenced by dietary intake, medication, renal handling, and other metabolic factors (Skoczynska et al., 2020), and has been associated with obesity and other metabolic disorders (Gong & Wang, 2020). Elevated uric acid has also been examined in relation to cardiovascular, vascular, and inflammatory outcomes (Freilich et al., 2022; Kimura et al., 2021; Yazdi et al., 2022). Participants with elevated readings were therefore advised regarding hydration, dietary moderation, symptom awareness, and clinical review when indicated.

Linking individual screening results with immediate counselling was an important practical strength of the program. All 50 participants received a written result card, an individual explanation, and follow-up advice, while the standardized educational poster provides a tool for maintaining consistency in future outreach activities. Nevertheless, delivery of education cannot be interpreted as demonstrated understanding. Completed teach-back forms were not available in the archived January 2026 record; therefore, quantitative evaluation was limited to verified service coverage, and participant comprehension or knowledge gain could not be assessed. Future cycles should administer the five-item teach-back checklist immediately after counselling to document participants' understanding of the screening results and recommended follow-up.

Finally, continuity of care remains an important area for improvement. Although participants with concerning findings received follow-up advice, the activity did not document whether they subsequently attended a healthcare facility. This is relevant because NCDs and multimorbidity can increase healthcare utilization and socioeconomic burden (Marthias et al., 2021). Future implementation should therefore strengthen referral linkage with a nearby primary healthcare facility and provide clear information on where and when repeat assessment should be obtained. Periodic implementation may also support evaluation of screening coverage, participant understanding, and referral completion over time (World Health Organization, 2025; Widyaningsih et al., 2025).

Conclusions

This community service program reached 50 adults through public-space blood glucose and uric acid screening combined with written results, brief health education, and follow-up advice. Most participants had normal-range or intermediate glucose readings, and 92.0% had uric acid readings within the normal-range category. Because the point-of-care measurements served as initial screening rather than diagnosis, participants with results requiring attention were advised to obtain repeat or confirmatory assessment. Periodic health screening and stronger linkage with healthcare facilities are important for continued preventive care.

Daftar Pustaka

- Arifin, H., Chou, K. R., Ibrahim, K., Ulfah, S., Pradipta, R. O., Rias, Y. A., Sitorus, N., Wiratama, B. S., Setiawan, A., Setyowati, S., Kuswanto, H., & Mediarti, D. (2022). Analysis of modifiable, non-modifiable, and physiological risk factors of non-communicable diseases in Indonesia: Evidence from the 2018 Indonesian Basic Health Research. *Journal of Multidisciplinary Healthcare*, 15, 2203-2221
- Bays, H. E., Taub, P. R., Epstein, E., Michos, E. D., Ferraro, R. A., Bailey, A. L., Kelli, H. M., Ferdinand, K. C., Echols, M. R., Weintraub, H., Bostrom, J., Johnson, H. M., Hoppe, K. K., Shapiro, M. D., German, C. A., Virani, S. S., Hussain, A., Ballantyne, C. M., Agha, A. M., & Toth, P. P. (2021). Ten things to know about ten cardiovascular disease risk factors. *American Journal of Preventive Cardiology*, 5, 100149. <https://doi.org/10.1016/j.ajpc.2021.100149>
- Budreviciute, A., Damiani, S., Sabir, D. K., Onder, K., Schuller-Goetzburg, P., Plakys, G., Katileviciute, A., Khoja, S., & Kodzius, R. (2020). Management and prevention strategies for non-communicable diseases and their risk factors. *Frontiers in Public Health*, 8, 574111. <https://doi.org/10.3389/fpubh.2020.574111>
- Ciarambino, T., Crispino, P., Leto, G., Mastrolorenzo, E., Para, O., & Giordano, M. (2022). Influence of gender in diabetes mellitus and its complication. *International Journal of Molecular Sciences*, 23(16), 8850.
- Freilich, M., Arredondo, A., Zonnoor, S. L., & McFarlane, I. M. (2022). Elevated serum uric acid and cardiovascular disease: A review and potential therapeutic interventions. *Cureus*, 14(3), e23582. <https://doi.org/10.7759/cureus.23582>
- Gong, M., & Wang, C. (2020). Converging relationships of obesity and hyperuricemia with special reference to metabolic disorders and plausible therapeutic implications. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 13, 943-962.
- Huang, Z., Xie, N., Illes, P., Di Virgilio, F., Ulrich, H., Semyanov, A., & Verkhatsky, A. (2021). From purines to purinergic signalling: Molecular functions and human diseases. *Signal Transduction and Targeted Therapy*, 6, 162. <https://doi.org/10.1038/s41392-021-00553-z>
- International Diabetes Federation. (2025). *IDF Diabetes Atlas (11th ed.)*. International Diabetes Federation.
- Kang, S., Kang, M., & Lim, H. (2021). Global and regional patterns in noncommunicable diseases and dietary factors across national income levels. *Nutrients*, 13(10), 3595.
- Kibret, K. T., Backholer, K., Peeters, A., & Tesfay, F. (2023). Burdens of non-communicable disease attributable to metabolic risk factors in regression analysis of the Global Burden of Disease Study. *BMJ Open*, 13(7), e071319. <https://doi.org/10.1136/bmjopen-2022-071319>
- Kimura, Y., Tsukui, D., & Kono, H. (2021). Uric acid in inflammation and the pathogenesis of atherosclerosis. *International Journal of Molecular Sciences*, 22(22), 12394.
- Marthias, T., Anindya, K., Ng, N., McPake, B., Atun, R., Arfyanto, H., Hulse, E. S. G., Zhao, Y., Jusril, H., Pan, T., Ishida, M., & Lee, J. T. (2021). Impact of non-communicable disease multimorbidity on health service use, catastrophic health expenditure and productivity loss in Indonesia: A population-based panel data analysis study. *BMJ Open*, 11(2), e041870. <https://doi.org/10.1136/bmjopen-2020-041870>

- Padda, J., Khalid, K., Padda, S., Boddeti, N. L., & Malhi, B. S. (2021). Hyperuricemia and its association with ischemic stroke. *Cureus*, 13(9), e18172. <https://doi.org/10.7759/cureus.18172>
- Setiyowati, P. A. I. (2020). The Effect of Mangosteen Pericarp (*Garcinia mangostana* L.) Extract on the Epididymal Spermatozoa Protein Profile of Mice Exposed to 2-Methoxyethanol. *BEST Journal (Biology Education Science & Technology)*, 3(2), 69-77. <https://doi.org/10.30743/best.v3i2.2809>
- Simbolon, D., Siregar, A., & Talib, R. A. (2020). Physiological factors and physical activity contribute to the incidence of type 2 diabetes mellitus in Indonesia. *Kesmas: Jurnal Kesehatan Masyarakat Nasional*, 15(3), 120-127. <https://doi.org/10.21109/kesmas.v15i3.3354>
- Skoczynska, M., Chowaniec, M., Szymczak, A., Langner-Hetmanczuk, A., Maciazek-Chyra, B., & Wiland, P. (2020). Pathophysiology of hyperuricemia and its clinical significance - A narrative review. *Reumatologia*, 58(5), 312-323.
- Widyaningsih, V., Augustania, C., Agustia, D., Febrinasari, R. P., Fritz, M., Koot, J., Landsman-Dijkstra, J., Postma, M. J., Grimm, M., & Probandari, A. (2025). Opportunities for improvement of community-based non-communicable disease screening practices in Indonesia: A participant satisfaction survey. *BMC Health Services Research*, 25, 1051. <https://doi.org/10.1186/s12913-025-13181-y>
- World Health Organization. (2025). Noncommunicable diseases. World Health Organization.
- Yazdi, F., Reza, M., Amir, S., Javad, M., Hamid, N., Fatemeh, N., & Samira, Y. (2022). Hyperuricaemia and its association with other risk factors for cardiovascular diseases: A population-based study. *Endocrinology, Diabetes & Metabolism*, 5(6), e00387. <https://doi.org/10.1002/edm2.387>