Improving NCD screening in Indonesia: Implementation of Aplikasi Sehat IndonesiaKu (ASIK)

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Abstract

Background: The escalating burden of non-communicable diseases (NCDs) in Indonesia poses a significant public health challenge. While mHealth technologies offer a promising solution, their widespread adoption and integration into primary healthcare services remain crucial for effective NCD management. The ASIK mobile application, as part of the Satu Sehat Platform, represents a valuable such mHealth tool for improving NCD screening and monitoring in Indonesia.

Objective: This study aims to describe the utilization of ASIK as an integrated primary care outreach activity reporting system and its use for electronically recording of NCDs screening in Public Health Center (Puskesmas) and Community Health Post (Posbindu) in Indonesia, from January 2023 to April 2024.

Methods: This study investigates the utilization of the ASIK mobile application as a non-communicable diseases (NCDs) screening reporting system. Healthcare workers and health cadres input screening data into the application, which is subsequently accessible on a monitoring dashboard. To optimize data analysis and coverage, integration with the existing SIPTM information system at the Ministry of Health (MoH) was implemented. Descriptive analysis was performed using open-source programming languages Python and R to characterize the NCDs screening results and assess the utilization coverage of ASIK.

Results: Based on the data recorded using ASIK, it was noted that there were 116,013,364 visits with a total of 75,822,322 participants in NCDs early detection screenings from January 2023 to April 2024, recorded from 10,131 (97.1%; 10,131/10,438) Puskesmas. A total of 68,372,564 (90.17%) people had blood pressure screening, 45,108,864 (59.49%) blood sugar screening, 65,156,641 (85.93%) Body Mass Index (BMI) measurement, 3,295,802 (4.35%) cholesterol screening, 60,331,731 (79.57%) waist circumference measurement, 50,606,659 (66.74%) hearing test, 45,006,175 (59.36%) vision test, 4,706,124 (11.13%) cervical cancer screening, and 6,379,842 (15.06%) breast cancer screening. Further analysis showed that NCD conditions were more prevalent in women compared to men and had the highest prevalence in the 45-59 age group.

Conclusions: This study highlights the potential of mHealth technologies, exemplified by the ASIK mobile application, to effectively address and implement non-communicable diseases (NCDs) screening in Indonesia. By improving access to healthcare and enhancing patient engagement, mHealth can significantly contribute to better NCD prevention, management, and outcomes.

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Abstract:

Background

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Based on the data recorded using ASIK, it was noted that there were 116,013,364 visits with a total of 75,822,322 participants in NCDs early detection screenings from January 2023 to April 2024, recorded from 10,131 (97.1%; 10,131/10,438) Puskesmas. A total of 68,372,564 (90.17%) people had blood pressure screening, 45,108,864 (59.49%) blood sugar screening, 65,156,641 (85.93%) Body Mass Index (BMI) measurement, 3,295,802 (4.35%) cholesterol screening, 60,331,731 (79.57%) waist circumference measurement, 50,606,659 (66.74%) hearing test, 45,006,175 (59.36%) vision test, 4,706,124 (11.13%) cervical cancer screening, and 6,379,842 (15.06%) breast cancer screening. Further analysis showed that NCD conditions were more prevalent in women compared to men and had the highest prevalence in the 45-59 age group.

Conclusions

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Keywords

primary healthcare; mHealth; NCDs screening; Public Health Centers

Introduction

The burden of disease in resource-restricted settings has shifted dramatically from communicable, maternal, and perinatal causes towards non-communicable diseases (NCDs) [1]. In 2019, NCDs, which include major chronic diseases such as hypertension, diabetes, depression, and their sequelae, were responsible for an estimated 42 million deaths globally. More than three-quarters of these deaths occurred in Low-and Middle-Income Countries (LMICs) [2, 3]. This has become a critical

public health challenge, triggered by multiple global demographic trends such as population aging, and dietary/lifestyle transitions [4-6]. People living in poor nations are particularly susceptible to NCDs due to health system vulnerabilities and high socioeconomic inequality [7, 8]. In particular, healthcare provider shortages in low-resource settings exacerbate these challenges, fueling the urgent need for innovative solutions [9].

Indonesia is currently experiencing a period of notable technological advancements, environmental changes, and lifestyle shifts towards modern living. These developments have significantly impacted the pattern of disease in society, leading to the increasing prevalence of NCDs [10]. The national basic research in 2018 has demonstrated this trend for diabetes (from 6.9% in 2013 to 10.9% in 2018) and hypertension (from 25.8% in 2013 to 34.1% in 2018) [11]. NCDs are responsible for 73% of deaths in Indonesia and the proportions are: cardiovascular disease (35%), cancer (12%), chronic respiratory diseases (6%), diabetes (6%), and the risk of premature death is more than 20% [12].

Changes in disease trends are also followed by shifts in disease patterns. It is alarming to note that the prevalence of NCDs is on the rise among younger age groups. Previously, NCDs were predominantly found among the elderly, but now, children aged 10-14 are also being affected by diseases such as stroke, cardiovascular disease, and diabetes [13]. To ensure the production of a healthy generation and make the best of Indonesia's anticipated demographic bonus as expected in 2030-2040, it is imperative to proactively control the trend of non-communicable diseases (NCDs) in children. The government's efforts will be bolstered by the implementation of preventive measures that will significantly reduce the risk of NCDs [14], as most NCDs are caused by preventable and modifiable factors [15]. The World Health Organization (WHO) has set a target to reduce the prevalence of non-communicable diseases (NCDs) by controlling behavioral risk factors such as alcohol and tobacco consumption, salt intake, and physical inactivity, as well as metabolic risk factors such as obesity and high blood pressure [16]. The Government of Indonesia (GoI), through the Ministry of Health (MoH) of the Republic of Indonesia has taken steps to combat NCDs since 2016 through a comprehensive program that includes reducing the consumption of salt, sugar, fat, alcohol, and tobacco, increasing physical activity, and promoting adequate tests. These measures are part of the National Action Plan on NCDs control [17]. The MoH has also launched various efforts to reduce and control the incidence of NCDs at the primary healthcare level, some examples of which are the NCD Integrated Service Program/Program Pelayanan Terpadu (PANDU) Penyakit Tidak Menular, the NCD Risk Factor Early Detection Program at the integrated community health posts/Pos Pembinaan Terpadu (Posbindu), and early detection of NCDs [18, 19]. This aims to reduce the incidence of NCDs and promote a healthier lifestyle for all Indonesians [18].

In November 2022, the Indonesian MoH launched its initiatives to accelerate the achievement of health goals through the implementation of six health transformation pillars which are: (1) transformation of primary service; (2) transformation of referral service; (3) transformation of health resilience system; (4) transformation of health financing system; (5) transformation of health human resources; and (6) transformation of health technology. One of the main focuses of health technology transformation is the digital transformation which takes advantage of novel information and

communication technology [20].

In recent years, the advances in mobile technologies and applications are driving the transformation in health services delivery globally. Mobile health (mHealth) technologies have been recognized as a cheaper and easier approach to providing high-quality healthcare services to patients in LMICs [21]. mHealth technology facilitates the automated transmission and exchange of health-related data [22]. With the increasing penetration of mobile phones in LMICs, healthcare services could reach more people in resource-restricted settings than the traditional forms of healthcare provision [23].

Specifically, as part of the digital health transformation initiatives, in May 2022 the MoH launched the mobile application called Aplikasi Satu Sehat IndonesiaKu (ASIK), integrated as part of the digital health ecosystem in the SatuSehat Platform. The SatuSehat Platform (SSP) exists and is built as a solution to the latent problems related to integration and many existing applications. SSP is a platform or ecosystem where all applications and users can be connected or incorporated in the same environment based on scalable, integrated, advanced and secure microservices.

Based on a current mapping, there are more than 400 health applications developed by the central and local governments. This condition has resulted in a fragmented landscape where health policies implementations are not based on comprehensive data and may result in inefficiencies in health services delivery. ASIK aims to reduce and simplify all related primary healthcare existing applications available which still lack data standardization and data exchange procedures [24]. ASIK was specifically developed to provide the healthcare workers and health cadres with a tool for data input and monitoring of healthcare services provided for communities outside the Public Health Center (Puskesmas) in primary healthcare services, such as immunization, maternal and child health, and nutrition, elderly health [25-27]. Puskesmas is defined as an essential health care unit that meets the needs of communities, is easy to access, acceptable, and affordable [28] and able to provide an integrated individual healthcare that includes the activity and a series of basic individual medical services to improve the individual health, preventing and curing disease. Providing essential public health services to the community includes health promotion, maternal and child health, nutrition, disease prevention and control, and environmental health [29].
In addition, NCDs screening is also conducted outside of Puskesmas, during field visits and integrated health services posts (Pos Pembinaan Terpadu, Posbindu; and Pos Pelayanan Terpadu, Posyandu), as community-based health interventions to improve the health and well-being of specific population groups within a defined local community. Based on the MoH Regulation Number 71 of 2015 concerning NCDs Management, the NCDs prevention activities conducted with an Integrated Service Program (Program Pelayanan Terpadu, PANDU) approach which consist of 1) health promotion, 2) risk factor early detection/screening at the integrated community health post (Posbindu/Posyandu), and 3) case management in primary health care facility, such as Puskesmas and clinic. [30]

This PANDU program is conducted by the Puskesmas health workers and health cadres routinely. Besides the health services provided in Puskesmas every day, there is Posbindu at every sub-village open one day every month run by the Puskesmas health workers and health cadres. During Posbindu services, all targeted populations of productive age and elderly (> 15 years old) will receive NCDs screening and health promotion information, including case management as needed. The NCDs screening covers a range of multiple tests such as blood pressure test, blood sugar test, cholesterol

test, uric acid test, BMI control, visual inspection of acetic acid (IVA test), breast clinical measurement, vision and cataract test, and COPD questionnaire test. Questionnaires related to dietary and lifestyle were also deployed during the screening activity covering individual and family NCDs history, salt, sugar, and fat consumption, vegetables and fruit consumption, alcohol consumption, smoking history, and physical activity. The questionnaire will be asked by the health cadres while multiple clinical tests are conducted by the healthcare workers. [30]

The MoH developed a web-based application called NCD information system (Sistem Informasi Penyakit Tidak Menular, SIPTM) in 2015 as the digital version of NCD screening data input and monitoring. Along with the digital health transformation initiatives, all related existing applications should be standardized, improved, and integrated into the SSP ecosystem. To improve the NCD screening data quality, digital utilization, and screening coverage, ASIK was then launched in May 2022 to become the official NCD screening application in primary healthcare settings, such as Puskesmas and Posyandu/Posbindu- and integrating the SIPTM functions. The aim of this study was to describe for the first time the utilization of ASIK and its use for electronically recording of NCDs screening in Puskesmas and Posbindu in Indonesia.

Methodology

Aplikasi Satu Sehat IndonesiaKu (ASIK) is an integrated application system developed by the MoH of the Republic of Indonesia for healthcare workers and health cadres to capture healthcare services provided for communities in Posyandu/Posbindu, and in Puskesmas (25, 26). This application is designed to facilitate healthcare workers in primary healthcare settings in recording patient data, reporting healthcare services provided for each individual, inputting routine health screening data, and monitoring patient conditions (25, 26).

The ASIK mobile application is available in both android and iOS versions and can be accessed through the Google Play Store and Apple App Store. In order to be eligible in reporting the healthcare services, healthcare workers need to register their accounts. Once registered and verified, healthcare workers can report related healthcare services, including NCDs screening provided to the community using ASIK to record individual data. Data reported through the ASIK mobile app is collected and automatically presented in an analytical dashboard provided in a web-version of ASIK which can be accessed in *sehatindonesiaku.kemkes.go.id*. This web-version of ASIK can only be accessed using a predetermined username and password for Puskesmas, District Health Offices, and Provincial Health Offices to monitor and evaluate the coverage of healthcare services in their respective areas. The data presented in the dashboard are automatically synchronized bottom-up from the Puskesmas level, up to the national level.

All NCDs screening data are inputted in ASIK by both health cadres and healthcare workers based on their roles in the program. During this activity, health promotion on NCDs prevention is also conducted (27). With ASIK, the healthcare workers and health cadres can directly input the screening result during or right after the services activity (24). Each record generated through ASIK is stored in a separate database and then automatically sent to the ASIK dashboard for data analysis. Processed data is distributed to various beneficiaries, such as health facilities, district and provincial health offices. All NCDs screening records from ASIK are monitored by the NCDs program coordinators in

Puskesmas in near real-time through the ASIK dashboard in a web-version. The NCDs screening features architecture in ASIK can be seen in Figure 1.

Several master databases serve as the sources of ASIK data, including the public health centers (Puskesmas) registry (abbreviated as REGPUS), the MoH Data and Information Centre database, and the Ministry of Home Affairs database. REGPUS provides information regarding the location of screening services, including names and locations of Puskesmas along with registered codes for each health facility. ASIK utilized data from the MoH Data and Information Centre to acquire information on the number of targeted screening participants for every district/city. During the process of recording individual data, an interconnected API with the Ministry of Home Affairs ensures data validation for citizen identification numbers and domicile information. The user interface of NCDs screening program in ASIK can be seen in Appendix 1.

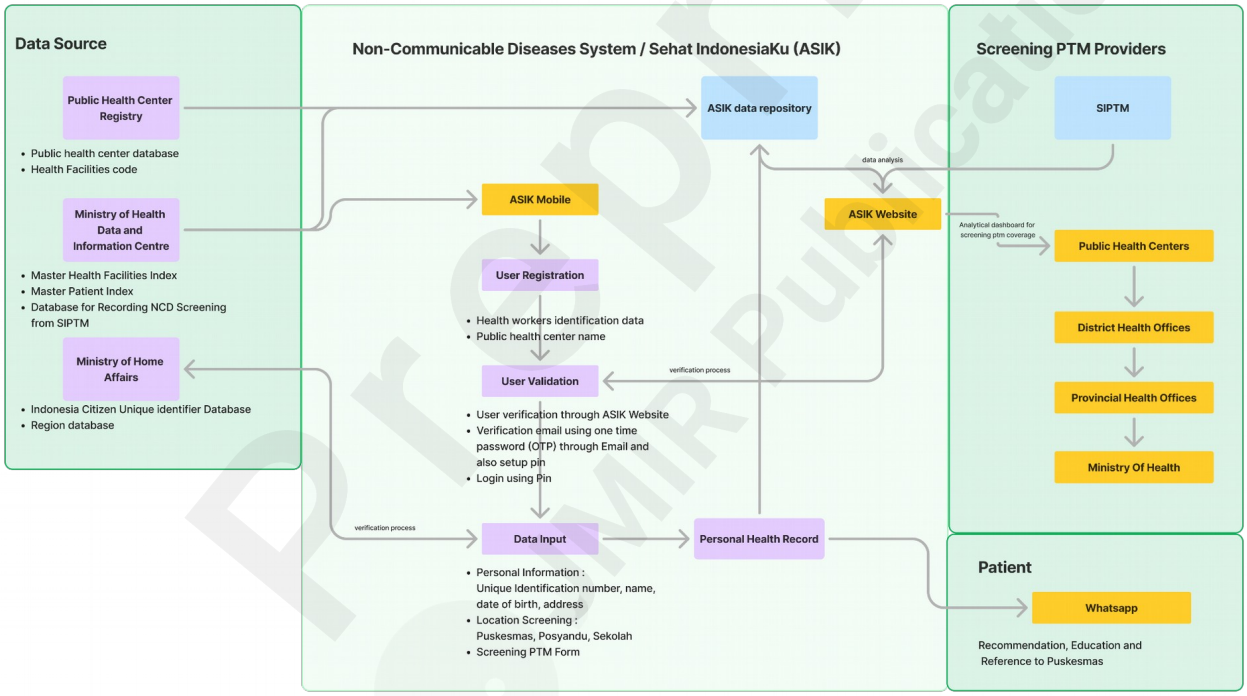

Figure 1. NCD Screening Architecture in ASIK

Data Collection

Data entry is initiated by selecting the NCDs Screening (Skrining PTM) menu within ASIK. To record individual data, either the 16 digits of the national identification number are entered or a combination of the full name and date of birth to locate the appropriate personal health record. Consequently, a list of relevant individuals will appear, allowing the users to select the relevant data or create a new identification record if the data were not available. To minimize error, the system was designed to display only the list of suitable NCDs screening for the individual's gender. For instance, for men, the system will not show IVA test and breast clinical examination in ASIK. The system also provides data input validation by applying data restriction for certain inputted numbers. For example,

the date of screening services cannot be input above the current date, body weight and height cannot be inputted if the numbers are not in the range of 10 to 250 kilograms, and 75 to 225 centimeters range.

The system automatically records the results of the screening services. It was recommended that healthcare workers and health cadres input the data immediately after the services had been provided, although the option for backdating the data input is also available in ASIK, allowing users to submit delayed reports.

To maximize the data analysis and coverage, integration with the existing information system at the MoH was also carried out. ASIK integrates the data from SIPTM which is the information system for recording NCD services. SIPTM is an information system that has been used by healthcare workers and health cadres since 2015 at public health centers to input data from the results of PTM screenings carried out in the Puskesmas. This integration is carried out so that past data that has previously been input into SIPTM can be analyzed with the latest data from ASIK.

Data Analysis

Descriptive analysis was conducted using open-source tools employing Python and R languages to describe the NCDs screening results and ASIK utilization coverage. Each NCDs screening has specific examination, examination results value cut off, results categories, targeted age and sex as described in Appendix 2.

Ethical Consideration

The data collected for this paper do not require ethical approval in accordance with the Indonesian MoH guideline “National Guideline and Standards for Ethical Research and Development in Health” (2017, Chapter IIIB, point 2, p. 46) (30), as no individual-level data are presented. The NCDs analysis data are in anonymized, aggregate format, and handled following the above-mentioned guidelines. No individual data were presented, only aggregated anonymised data used as per above. [31]

Results

NCDs Screening Results

Based on the results of healthcare services recorded using the ASIK Mobile Application, it was noted that there were 116,013,364 visits with a total of 75,822,322 participants in NCDs early detection screening from January 2023 to April 2024. Specifically, 68,372,564 (90.17%) people had blood pressure screening, 45,108,864 (59.49%) blood sugar screening, 65,156,641 (85.93%) Body Mass Index (BMI) measurement, 3,295,802 (4.35%) cholesterol screening, 60,331,731 (79.57%) waist circumference measurement, 50,606,659 (66.74%) hearing test, 45,006,175 (59.36%) vision test, 4,706,124 (11.13%) cervical cancer screening, and 6,379,842 (15.06%) breast cancer screening.

In a time series analysis, over a 16-month monitoring period, the average number of visits was 7,250,835.25 per month with 4,738,895.13 people screened for NCDs (see Figure 2). The highest number of visits and the highest number of people screened was in January 2024 (8,628,718 and 7,538,886 respectively).

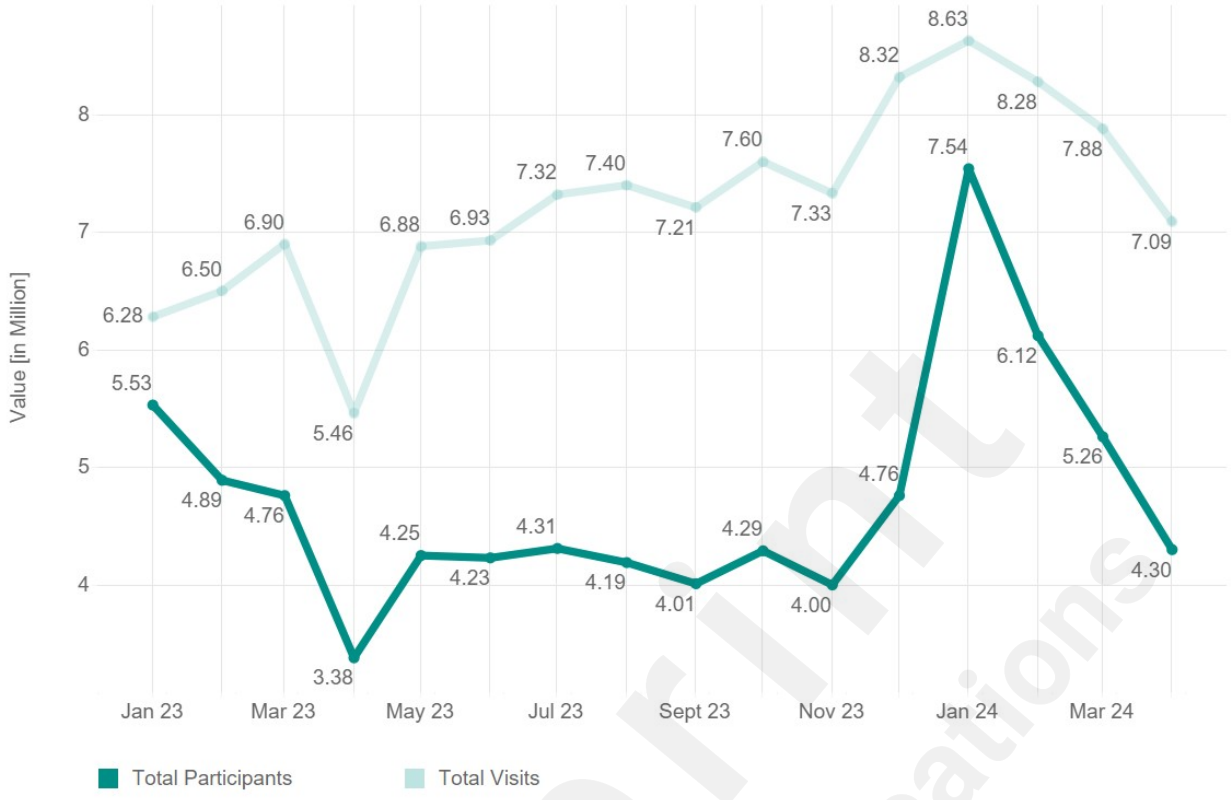

Figure 2. NCDs screening visit trend and unique number of individuals screened January 2023 - April 2024

Figure 3 showed the number of NCDs screening visits and screened individuals based on the provinces in Indonesia. Across 34 of the 38 provinces that constitute the country, the highest NCDs screening participation was observed in East Java (17,658,433), followed by West Java (13,237,091), Banten (6,539,972), and Special Capital Region of Jakarta (6,350,717). In contrast, the lowest number of NCDs screening participation was observed in Highland Papua (831), followed by South Papua (8,834), Southwest Papua (22,994), and Central Papua (22,427).

No.	Province	Total Participants	Total Visits
1	East Java	17,658,433	28,612,456
2	West Java	13,237,091	23,021,304
3	Banten	6,539,972	11,834,420
4	Special Capital Region of Jakarta	6,350,717	9,018,593
5	Central Java	5,509,668	7,284,835
6	North Sumatera	3,221,686	4,253,694
7	Lampung	3,035,288	3,482,461
8	West Nusa Tenggara	3,010,245	4,970,000
9	South Sulawesi	2,204,877	2,885,164
10	South Kalimantan	1,242,102	1,739,771
11	East Nusa Tenggara	1,091,137	1,331,114
12	West Sumatera	1,052,999	1,253,405
13	Riau Islands	1,034,476	1,587,558
14	Riau	929,241	1,209,367
15	West Kalimantan	926,520	1,318,895
16	East Kalimantan	907,961	1,299,417
17	Gorontalo	871,451	1,238,862
18	South Sumatera	866,293	1,209,776
19	Bali	783,507	1,135,819
20	Aceh	721,335	977,111
21	Jambi	718,149	866,726
22	Central Sulawesi	678,263	806,827
23	Southeast Sulawesi	615,091	955,695
24	Special Region of Yogyakarta	471,217	824,986
25	North Sulawesi	377,211	479,101
26	Central Kalimantan	327,285	533,874
27	Bengkulu	311,467	432,987
28	Bangka Belitung Islands	270,245	329,016
29	Maluku	220,880	307,682
30	North Maluku	199,400	267,505
31	West Sulawesi	192,339	231,189
32	North Kalimantan	84,357	98,134
33	Papua	57,203	74,657
34	West Papua	46,130	63,608
35	Central Papua	25,427	37,210
36	Southwest Papua	22,994	28,700
37	South Papua	8,834	10,187
38	Highland Papua	831	1,258

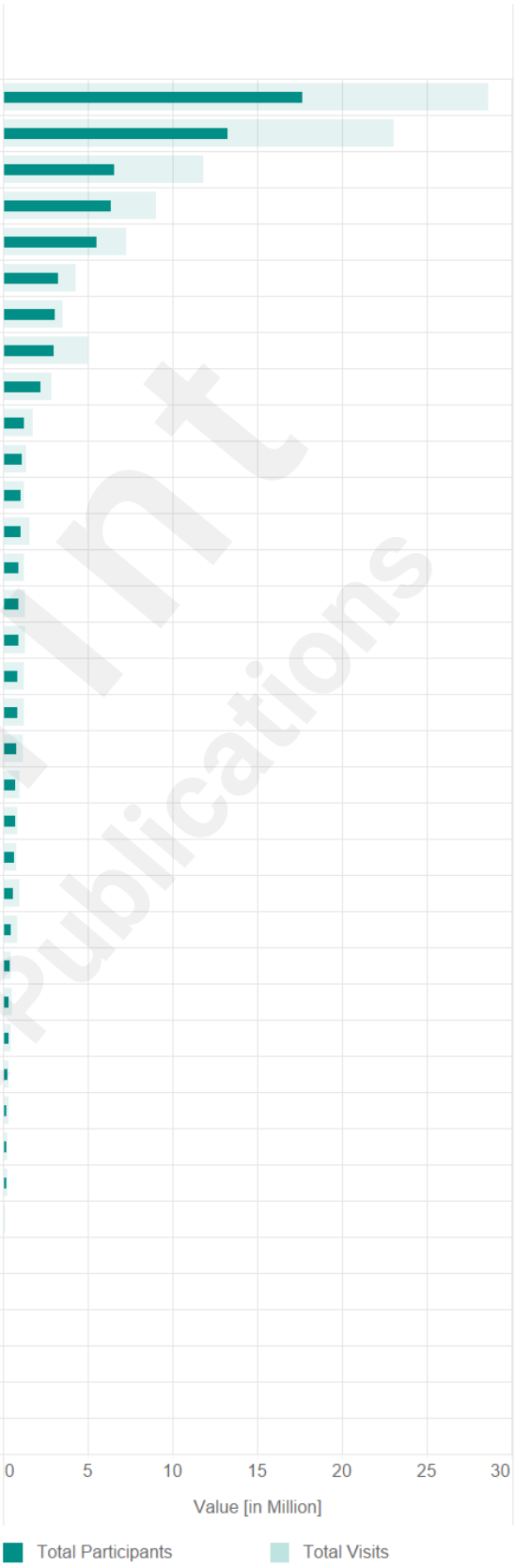

Figure 3. NCDs Screening across 38 provinces in Indonesia

Based on the data results, the NCDs screening shows that 27.98% (19,131,845/68,372,564) of individuals had hypertension, 2.43% (1,095,119/45,108,864) had diabetes mellitus, 27.25% (897,968/3,295,802) had dyslipidemia. In addition, 19.28% (12,562,097/65,156,641) were obese and 32.18% (19,412,018/60,331,731) had central obesity (see table 1). Hearing and vision tests showed

that 1.50% (758,528/50,606,659) screened individuals had hearing impairment and 5.59% (2,515,554/45,006,175) had vision impairment. The cervical cancer screening found that 1.73% (81,425/4,706,124) women were IVA positive.

Table 1. NCDs Screening Results Based on Sex

No	Type of Screening	Total		Male		Female	
		n	%	n	%	n	%
Total NCDs Screening Participant		75,822,322	100.00	33,541,334	44.24	42,280,988	55.76
1	**Blood Pressure Screening**	68,372,564	90.17	30,113,297	44.04	38,259,267	55.96
	Normal	19,032,994	27.84	8,025,746	11.74	11,007,248	16.10
	Prehypertension	30,207,725	44.18	13,909,370	20.34	16,298,355	23.84
	Hypertension	19,131,845	27.98	8,178,181	11.96	10,953,664	16.02
2	**Blood Sugar Screening**	45,108,864	59.49	19,888,297	44.09	25,220,567	55.91
	Normal	35,909,106	79.61	16,050,665	35.58	19,858,441	44.02
	Pre-Diabetes Mellitus	8,104,639	17.97	3,400,199	7.54	4,704,440	10.43
	Diabetes Mellitus	1,095,119	2.43	437,433	0.97	657,686	1.46
3	**Cholesterol Screening**	3,295,802	4.35	1,525,735	46.29	1,770,067	53.71
	Normal	2,397,834	72.75	1,197,931	36.35	1,199,903	36.41
	Dyslipidemia	897,968	27.25	327,804	9.94	570,164	17.30
4	**BMI Measurements**	65,156,641	85.93	28,526,348	43.78	36,630,293	56.22
	Underweight	4,290,157	6.58	1,965,860	3.02	2,324,297	3.57
	Normal	40,478,230	62.12	18,627,323	28.59	21,850,907	33.54
	Overweight	7,826,157	12.01	3,261,596	5.01	4,564,561	7.01
	Obesity	12,562,097	19.28	4,671,569	7.17	7,890,528	12.11
5	**Waist Circumference Measurement**	60,331,731	79.57	26,536,218	43.98	33,795,513	56.02
	Normal	40,919,713	67.82	22,776,146	37.75	18,143,567	30.07
	Central Obesity	19,412,018	32.18	3,760,072	6.23	15,651,946	25.94
7	**Hearing test**	50,606,659	66.74	22,237,599	43.94	28,369,060	56.06
	Normal	49,848,131	98.50	21,894,499	43.26	27,953,632	55.24
	Hearing impairment	758,528	1.50	343,100	0.68	415,428	0.82
8	**Vision test**	45,006,175	59.36	19,613,647	43.58	25,392,528	56.42
	Normal	42,490,621	94.41	18,520,378	41.15	23,970,243	53.26

	Vision impairment	2,515,554	5.59	1,093,269	2.43	1,422,285	3.16
9	**Breast cancer screening**	6,379,842	15.06	0	0.00	6,379,842	100.00
	Normal	6,339,052	99.36	0	0.00	6,339,052	99.36
	Suspected cancer	21	0.00	0	0.00	21	0.00
	Confirmed cancer	40,769	0.64	0	0.00	40,769	0.64
10	**Cervical cancer screening**	4,706,124	11.13	0	0.00	4,706,124	100.00
	IVA negative	4,623,464	98.24	0	0.00	4,623,464	98.24
	Suspected cancer	1,235	0.03	0	0.00	1,235	0.03
	IVA positive	81,425	1.73	0	0.00	81,425	1.73

Further analysis showed that NCD conditions were more prevalent in women as compared to men (see Figure 4). 17.30% (570,164/897,968) of women had dyslipidemia compared to men 9.95% (327,804/897,968); 12.11% (7,890,528/12,562,097) women had obesity compared to 7.17% (4,671,569/12,562,097) in men; and 1.46% (657,686/1,095,119) women were hyperglycemic compared to 0.97% (437,433/1,095,119) in men. In addition, 16.02% (10,953,664/19,131,845) of women had hypertension compared to 11.96% (8,178,181/19,131,845) in men; 3.16% (1,422,285/2,515,554) of women had visual impairment compared to 2.43% (1,093,269/2,515,554) in men; and 0.82% (415,428/758,528) of women had hearing impairment compared to 0.68% (343,100/758,528) in men.

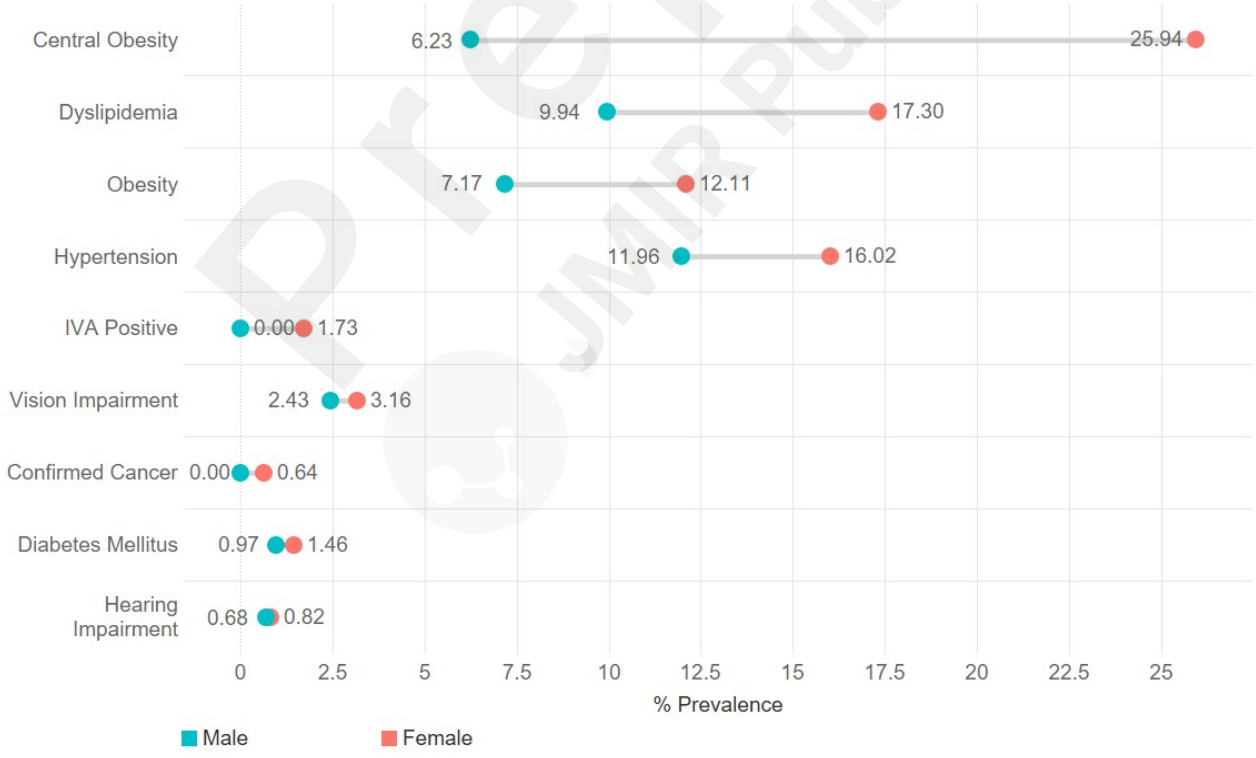

Figure 4. Difference in screening result proportions between male and female, sorted by gender gap

Based on figure 5, obesity, regardless of being measured by BMI or waist circumference, has the highest prevalence in the 45-59 age group. Dyslipidemia and hyperglycemia peak in the 60-69 age

group, while hypertension, vision impairment, hearing impairment, and cervical cancer have the highest prevalence in individuals aged 70 and above. Contrary, breast cancer has the highest prevalence among the youngest age group compared to all other screenings, occurring in women aged 15-24 years.

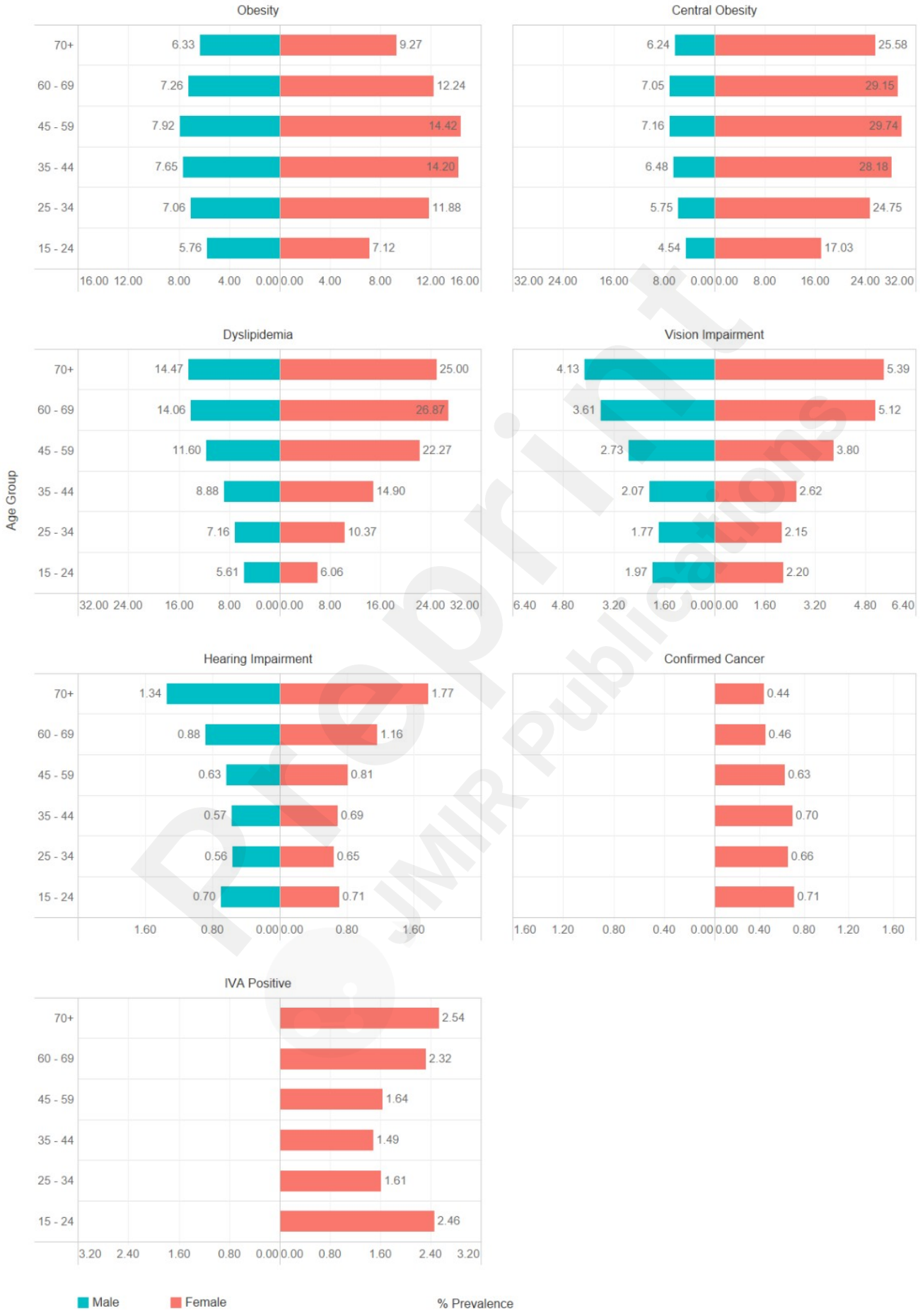
Obesity
70+ 6.33 9.27
60 - 69 7.26 12.24
45 - 59 7.92 14.42
35 - 44 7.65 14.20
25 - 34 7.06 11.88
15 - 24 5.76 7.12
16.00 12.00 8.00 4.00 0.00 0.00 4.00 8.00 12.00 16.00
Central Obesity
6.24 25.58
7.05 29.15
7.16 29.74
6.48 28.18
5.75 24.75
4.54 17.03
32.00 24.00 16.00 8.00 0.00 0.00 8.00 16.00 24.00 32.00
Dyslipidemia
14.47 25.00
14.06 26.87
11.60 22.27
8.88 14.90
7.16 10.37
5.61 6.06
32.00 24.00 16.00 8.00 0.00 0.00 8.00 16.00 24.00 32.00
Vision Impairment
4.13 5.39
3.61 5.12
2.73 3.80
2.07 2.62
1.77 2.15
1.97 2.20
6.40 4.80 3.20 1.60 0.00 0.00 1.60 3.20 4.80 6.40
Age Group
Hearing Impairment
1.34 1.77
0.88 1.16
0.63 0.81
0.57 0.69
0.56 0.65
0.70 0.71
1.60 0.80 0.00 0.00 0.80 1.60
Confirmed Cancer
0.44
0.46
0.63
0.70
0.66
0.71
1.60 1.20 0.80 0.40 0.00 0.00 0.40 0.80 1.20 1.60
IVA Positive
2.54
2.32
1.64
1.49
1.61
2.46
3.20 2.40 1.60 0.80 0.00 0.00 0.80 1.60 2.40 3.20
Male
Female
% Prevalence

Figure 5. NCD Screening Results based on Gender and Age Groups

ASIK Utilization Coverage

A total of 10,131 (97.1%; 10,131/10,438) Puskesmas in 509 (99%; 509/514) districts/cities across 38 provinces (100%; 38/38) have reported early detection activities for NCDs using the ASIK Application (see Figure 6). Based on provincial data, there are 10 provinces where 100% of the Puskesmas have reported NCDs screening activities using ASIK, namely East Nusa Tenggara, South Sumatera, South Kalimantan, Central Sulawesi, Jambi, Bengkulu, Special Region of Yogyakarta, Bali, West Sulawesi, and Bangka Belitung Islands (see Appendix 3). On the other hand, the provinces with the lowest reporting rates are Highland Papua where only 13,29% (19/143) Puskesmas have reported), followed by Special Capital Region of Jakarta 26.67% (84/315) Puskesmas reported), Central Papua 49.17% (59/120 Puskesmas reported), and South Papua 56.47% (44/85 Puskesmas reported).

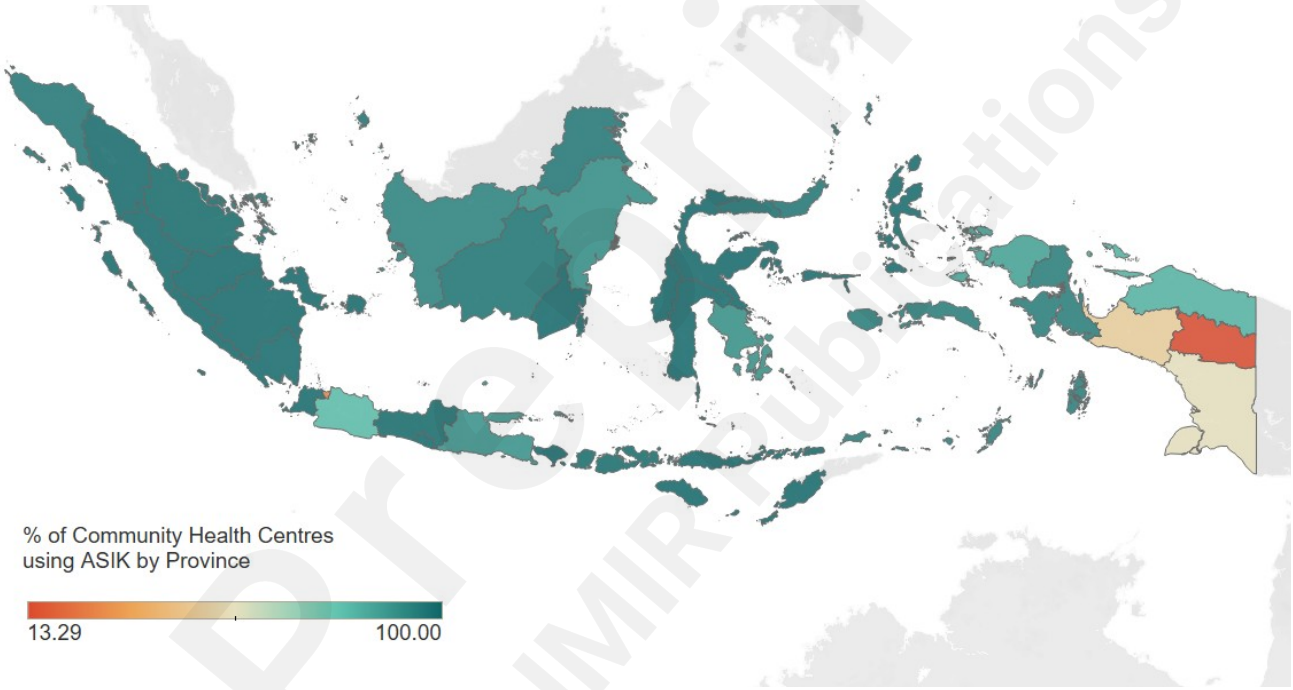

Figure 6. ASIK utilization across 38 provinces Indonesia

Discussion

The widespread adoption of mobile health (mHealth) technologies presents a promising avenue for addressing the global burden of NCDs. Prior to the advent of mHealth, managing NCDs was impeded by several challenges, including limited access to healthcare facilities, extended waiting times, and inadequate patient-provider interactions. mHealth interventions have the potential to mitigate these barriers by enabling remote health monitoring, facilitating communication between patients and healthcare providers, and streamlining diagnostic processes. Numerous studies have demonstrated the efficacy of mHealth interventions in various countries and regions for the prevention and management of NCDs. For instance, text message-based interventions have been shown to effectively promote healthy behaviors, such as physical activity and dietary changes, and to improve medication adherence among individuals with chronic conditions [32, 33]. Additionally,

mHealth platforms can empower patients to self-report symptoms, track vital signs, and participate in screening activities, thereby fostering greater engagement in their own health management [34, 35]. By digitizing data collection and analysis, mHealth systems can enhance the efficiency and accuracy of NCD screening and diagnosis. Automated data transmission can reduce errors and delays in reporting, while the integration of individual data with electronic health records can ensure comprehensive and accessible patient information. Moreover, near real-time data analysis can inform decision-making, optimize service delivery, and evaluate the impact of interventions on population health outcomes [36-37]. mHealth technologies offer a promising solution to the challenges associated with managing NCDs. By leveraging the power of mobile devices and digital health tools, healthcare providers can improve access to care, enhance patient engagement, and ultimately improve health outcomes for individuals with chronic conditions.

The ASIK mobile application (a mHealth technology) has been utilized by 10,131 Puskesmas (public health centers) in Indonesia, resulting in 116,013,364 screening results for NCDs from January 2023 to April 2024. Blood pressure screening, with 68,372,564 individuals tested, constituted the most prevalent screening modality, followed by blood sugar screening (45,108,864) and cholesterol screening (3,295,802). Analysis of the screening results revealed a disproportionate burden of NCDs among women aged 45-59. Across all screening categories—hypertension, hyperglycemia, obesity, dyslipidemia, hearing impairment, and visual impairment—females in this age group exhibited higher prevalence rates. These findings align with existing research, which attributes women's increased susceptibility to NCDs to biological factors such as higher rates of overweight, elevated blood pressure, glucose, and cholesterol levels (WHO, 2020). Furthermore, women with multiple risk factors are known to have a three to eleven times higher risk of NCDs compared to younger women [38]. While gender plays a significant role in NCD risk, it is important to acknowledge the influence of other factors such as education, marital status, working status, and access to healthcare services [38-41]. A comprehensive understanding of NCD risk factors requires consideration of both biological, demographic and socio-economic determinants.

The ASIK mobile application has achieved widespread adoption across Indonesia, with its usage for recording early detection screenings extending to all provinces except for five cities. This comprehensive coverage underscores ASIK's potential to provide a representative overview of the population's health status, identifying individuals at risk or affected by NCDs. Similar to ASIK, the Casalud mobile application in Mexico is designed to proactively prevent NCDs through screening and risk factor assessment. However, Casalud's coverage remains more limited, encompassing only seven out of 32 states [33]. In other countries, such as Switzerland, Malaysia, Thailand, Brazil, and India, the utilization of mHealth technologies for NCD management is often confined to specific conditions, including weight management, osteoarthritis, pain management, blood pressure, and diabetes [23, 35, 42, 43]. These examples highlight the varying degrees of mHealth adoption and implementation across different regions and healthcare systems.

The screening results obtained through the ASIK mobile application generally align with the findings of the National Health Survey 2023 [44]. For instance, ASIK identified hypertension in 28.01% of the population, while the National Health Survey reported a prevalence of 29.2%. Similarly, ASIK detected diabetes mellitus in 2.43% of individuals, compared to the National Health Survey's estimate of 2.2%.

These concordant results demonstrate the effectiveness of mHealth technologies as digital health interventions in optimizing clinical practices [43]. Given its potential to save time and costs while maintaining reliability in both urban and rural settings, mHealth holds significant promise for implementation in LMICs. The ability of mHealth to facilitate nationwide data sharing offers a more

efficient means for stakeholders to monitor the burden of NCDs [45]. However, it is noteworthy that the global adoption of mHealth for screening NCDs remains predominantly concentrated in high-income countries. While LMICs have made strides in mHealth adoption, their usage rates still lag behind those of high-income nations, accounting for approximately one-third of the global total [34].

Strength and Limitations

The research exhibits several strengths that contribute to its significance in the field. This is the first study describing the implementation of integrated NCDs screening reporting system from community outreach activities at primary health care services that can be analyzed and monitored from the Puskesmas, district/city, province to national levels. However, certain limitations should be acknowledged namely: (i) The data displayed is only from early detection program at community outreach activities, not yet integrated with NCDs data at inpatient services (ii) ASIK is only available and used by the Puskesmas staff, not by the clinics, so the reporting results can only be inputted by officers from Puskesmas and Posyandu/Posbindu (iii) others. Nevertheless, this study provides a deeper picture related to the utilization of ASIK in the Early Detection of NCDs program implemented nationally by the MoH.

Conclusions

This study demonstrates the potential of mHealth technologies to address the global burden of NCDs. By overcoming barriers such as limited access to healthcare and inadequate patient-provider interactions, mHealth interventions can improve NCD prevention, management, and outcomes. The ASIK mobile application, specifically, has proven to be a valuable tool for NCD screening and monitoring in Indonesia with many millions of individuals screened and provided with appropriate healthcare advice, across almost the entirety of the country. Its widespread adoption, scale-up and integration with existing healthcare systems highlight its potential for improving population health. In conclusion, mHealth technologies offer a promising avenue for addressing the global NCD epidemic. By leveraging the power of mobile devices and digital health tools, healthcare providers can improve access to care, enhance patient engagement, and ultimately improve health outcomes for individuals with chronic conditions.

Disclaimer:

Where authors are identified as personnel of the International Agency for Research on Cancer/WHO, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy or views of the International Agency for Research on Cancer/WHO.

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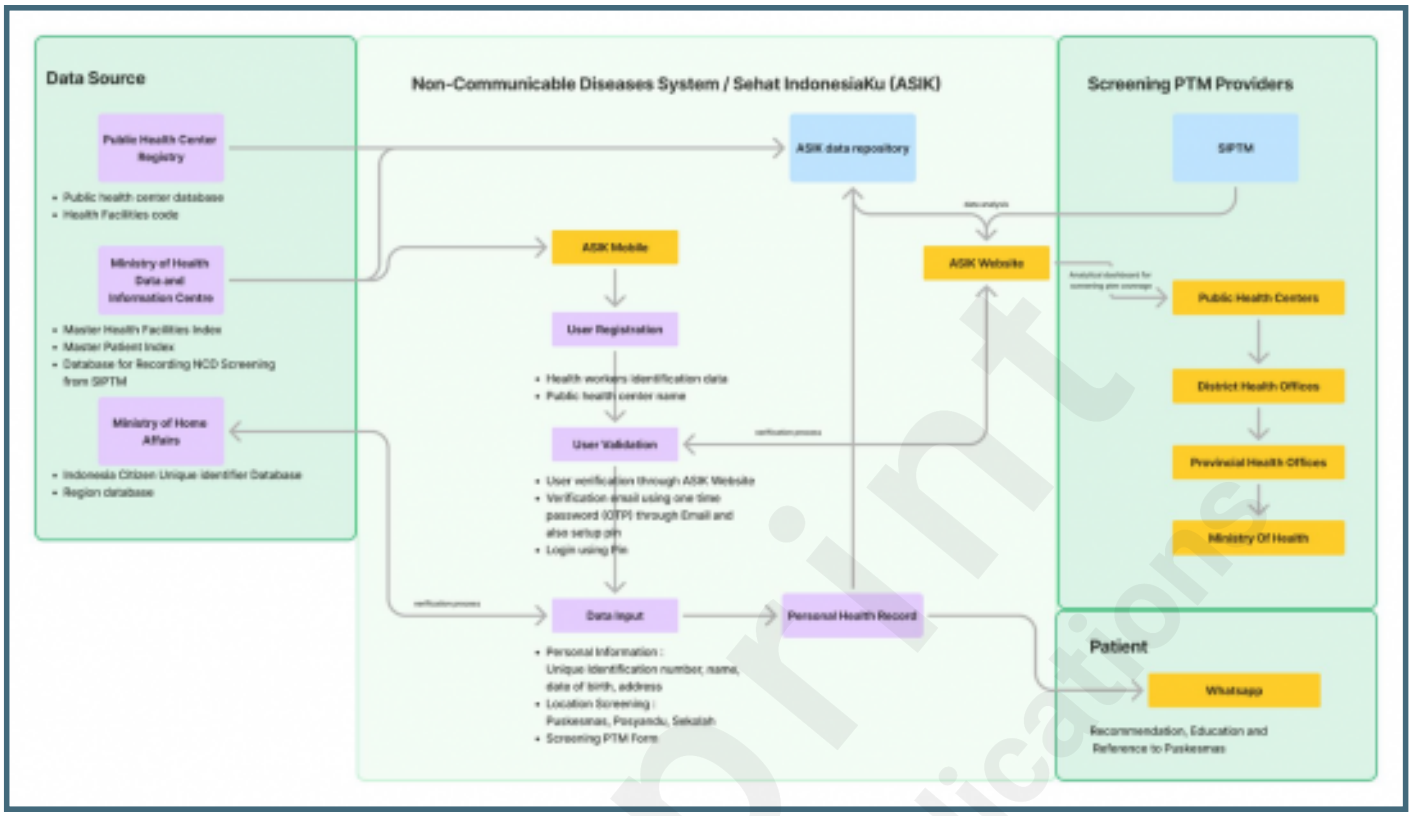
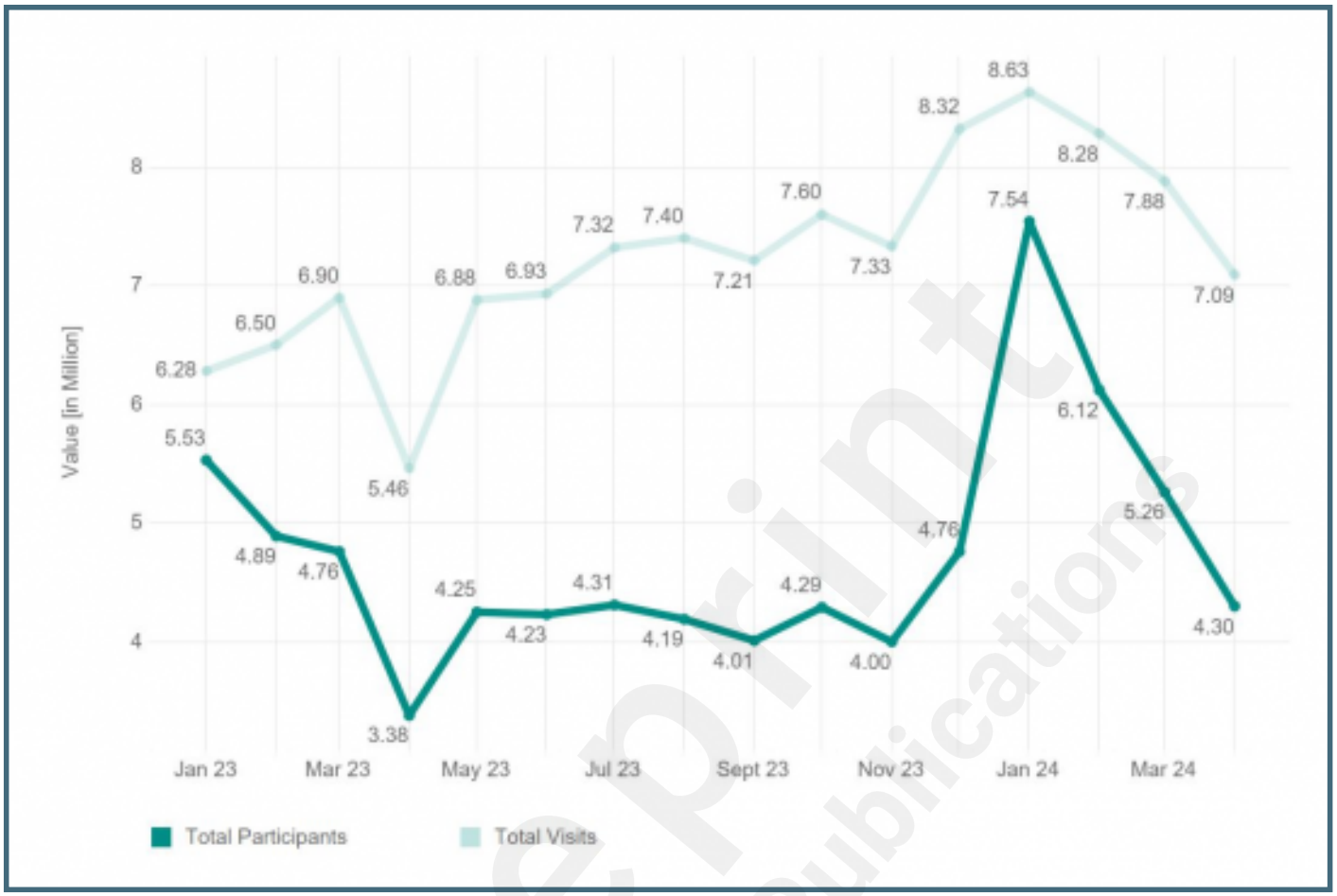
Supplementary Files

Figures

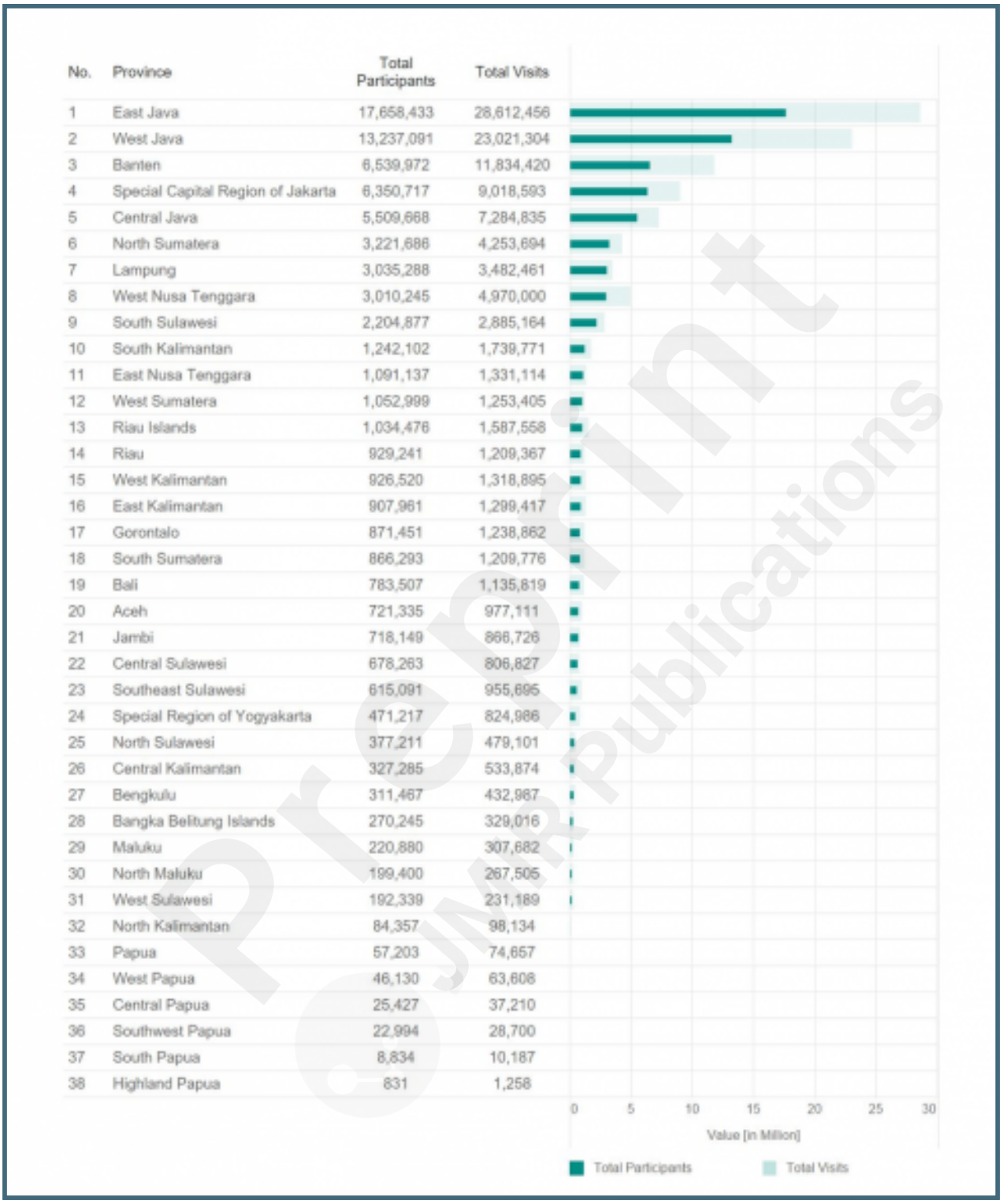
NCD Screening Architecture in ASIK.



NCDs screening visit trend and unique number of individuals screened January 2023 - April 2024.

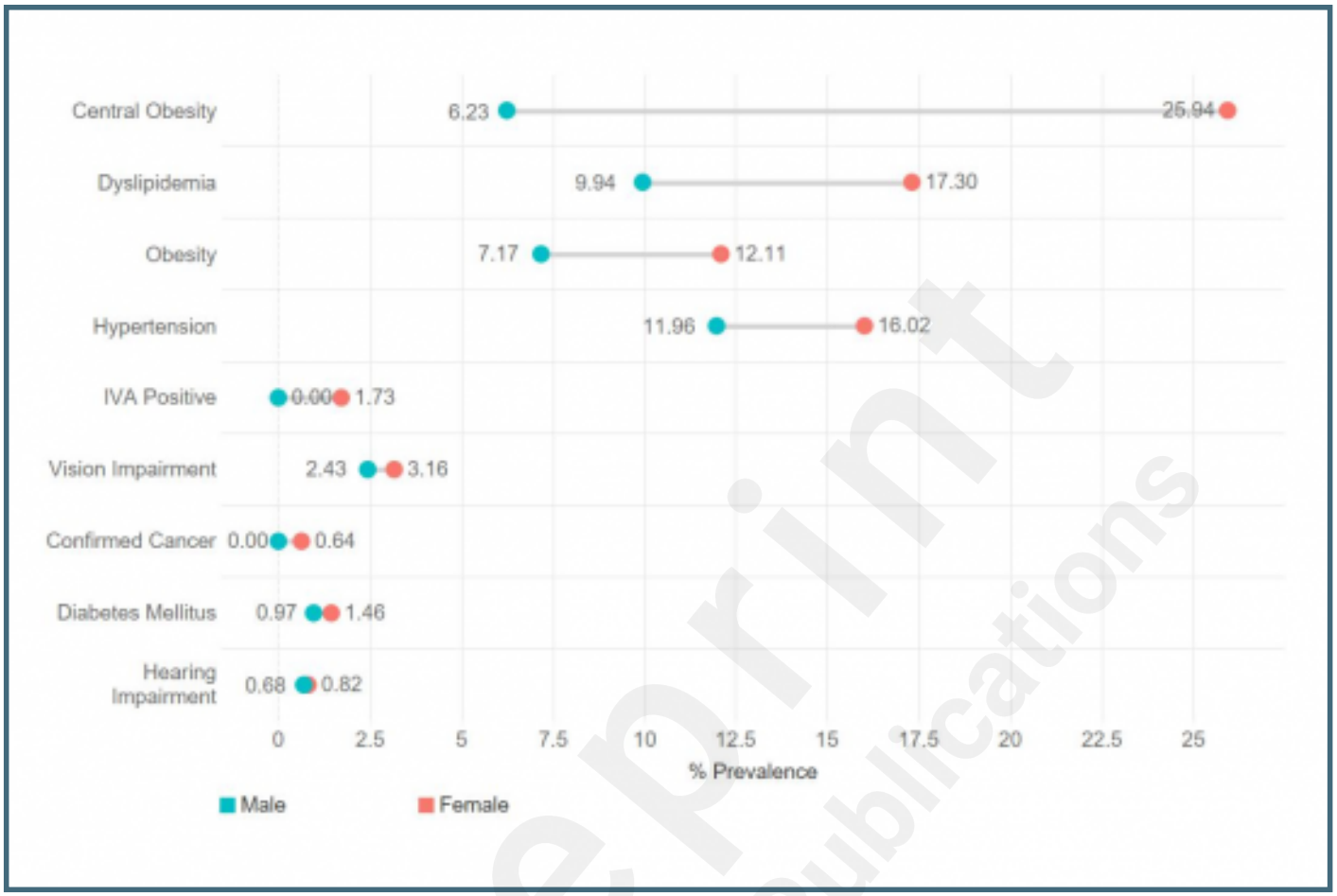


NCDs Screening across 38 provinces in Indonesia.



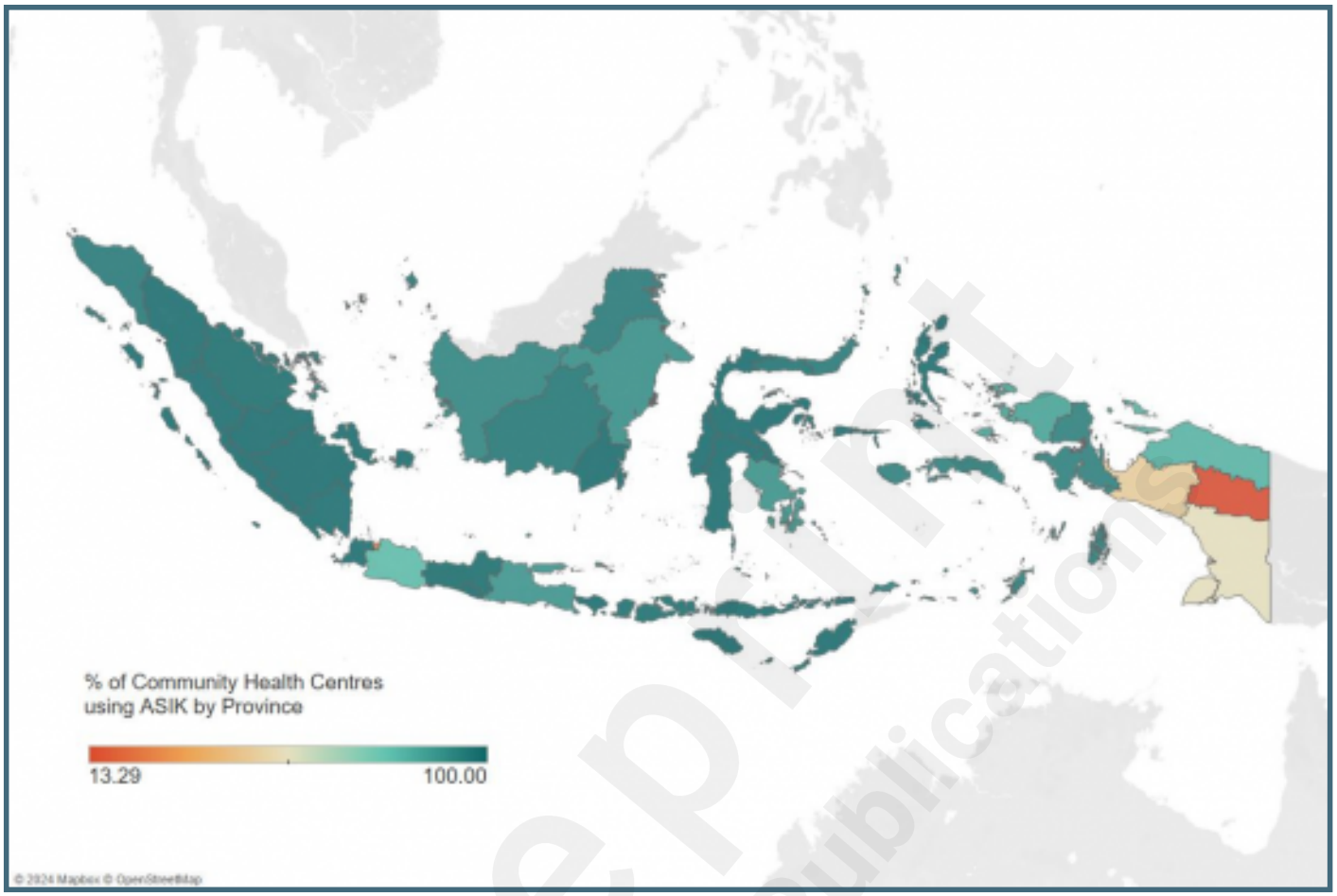
No.	Province	Total Participants	Total Visits
1	East Java	17,658,433	28,612,456
2	West Java	13,237,091	23,021,304
3	Banten	6,539,972	11,834,420
4	Special Capital Region of Jakarta	6,350,717	9,018,593
5	Central Java	5,509,668	7,284,835
6	North Sumatera	3,221,686	4,253,694
7	Lampung	3,035,288	3,482,461
8	West Nusa Tenggara	3,010,245	4,970,000
9	South Sulawesi	2,204,877	2,885,164
10	South Kalimantan	1,242,102	1,739,771
11	East Nusa Tenggara	1,091,137	1,331,114
12	West Sumatera	1,052,999	1,253,405
13	Riau Islands	1,034,476	1,587,558
14	Riau	929,241	1,209,367
15	West Kalimantan	926,520	1,318,895
16	East Kalimantan	907,961	1,299,417
17	Gorontalo	871,451	1,238,862
18	South Sumatera	866,293	1,209,776
19	Bali	783,507	1,135,819
20	Aceh	721,335	977,111
21	Jambi	718,149	866,726
22	Central Sulawesi	678,263	806,827
23	Southeast Sulawesi	615,091	955,695
24	Special Region of Yogyakarta	471,217	824,986
25	North Sulawesi	377,211	479,101
26	Central Kalimantan	327,285	533,874
27	Bengkulu	311,467	432,967
28	Bangka Belitung Islands	270,245	329,016
29	Maluku	220,880	307,682
30	North Maluku	199,400	267,505
31	West Sulawesi	192,339	231,189
32	North Kalimantan	84,357	98,134
33	Papua	57,203	74,657
34	West Papua	46,130	63,606
35	Central Papua	25,427	37,210
36	Southwest Papua	22,994	28,700
37	South Papua	8,834	10,187
38	Highland Papua	831	1,258

Difference in screening result proportions between male and female, sorted by gender gap.



NCD Screening Results based on Gender and Age Groups.

ASIK utilization across 38 provinces Indonesia.



Multimedia Appendixes

ASIK User Interface for NCDs Screening Program.
URL: http://asset.jmir.pub/assets/7b27946bf9b886b63357b747cabeae45.png

NCDs Screening Details.
URL: http://asset.jmir.pub/assets/3560e3a9cc5e05fc5b294942ec318ecf.docx

ASIK Utilization.
URL: http://asset.jmir.pub/assets/11293800900f736f036adcec471a65c3.docx