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Key influencers of puberty knowledge among Indonesian adolescents: the role of social networks

Dedik Sulistiawan[1], Riza Fatma Arifa[2], Ratu Matahari[1], Syariatul Dirgantara[1], Pairote Chakranon[3]
[1]Department of Public Health, Faculty of Public Health, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2]National Research and Innovation Agency, Jakarta, Indonesia
[3]School of Public Health, College of Public Health, Taipei Medical University, New Taipei, Taiwan

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ABSTRACT

Accurate reproductive health knowledge is essential for adolescents, yet many in Indonesia poorly informed, contributing to risky behaviors. While prior studies have focused on the effectiveness of reproductive health promotion media, limited research has explored the role of social networks in shaping adolescent reproductive health knowledge. This study aimed to investigate the key influencers within adolescents' social networks by analyzing the association between discussion partners on sexuality and knowledge of puberty-related traits. This cross-sectional study utilized data from the 2017 Indonesia Demographic and Health Survey, with a sample of 23,361 unmarried adolescents. We assessed knowledge of puberty onset traits and discussion partners on sexuality issues as predictors. Multiple logistic regression, adjusted for age, gender, wealth index, and residence, was employed to calculate odds ratios with 95% confidence intervals. Approximately half of the adolescents demonstrated a good knowledge of puberty-related traits. Engaging in discussions about sexuality with friends, mothers, relatives, teachers, and health professionals was positively associated with higher knowledge levels. Adolescents who engaged with these sources were more likely to have a better understanding of puberty-related traits. Utilizing key influencers within these networks can be crucial in promoting accurate reproductive health knowledge and reducing risky behaviors in this population.

Corresponding Author:

Dedik Sulistiawan
Department of Public Health, Faculty of Public Health, Universitas Ahmad Dahlan
St. Prof. Dr. Soepomo, Yogyakarta 55164, Indonesia
Email: dedik.sulistiawan@ikm.uad.ac.id

1. INTRODUCTION

Adolescent health is a critical focus in public health, as it encompasses the physical, emotional, and social changes that occur during this transformative stage of life [1], [2]. Puberty, in particular, marks a key developmental phase where adolescents experience significant biological and hormonal shifts, shaping their overall health and future well-being [2]. During this period, adolescents must acquire accurate knowledge about reproductive health to navigate the complexities of puberty and make informed decisions about their bodies and behaviors. Comprehensive reproductive health education is essential, as it equips adolescents with the necessary tools to understand these changes, fosters healthy behaviors, and helps prevent misconceptions and risky practices [3]-[5].

However, despite the implementation of various reproductive health programs, adolescents continue to face significant challenges in understanding puberty. These challenges include limited access to accurate

information, cultural taboos surrounding discussions of sexuality, and inconsistent delivery of reproductive health education [6]-[9]. In many settings, particularly low- and middle-income countries, reproductive health curricula are underdeveloped or not adequately implemented, leaving adolescents vulnerable to misinformation [10]-[12]. Globally, many adolescents continue to lack comprehensive knowledge of puberty and reproductive health, which contributes to risky behaviors such as early sexual initiation, unprotected sex, and increased rates of sexually transmitted infections (STIs) and adolescent pregnancies [13], [14]. In Indonesia, these gaps are particularly pronounced, with a significant number of adolescents uninformed or misinformed about critical topics such as menstruation, contraception, and STIs prevention [4]. According to the Indonesia Performance and Accountability Survey by the National Population and Family Planning Board (BKKBN) in 2019, most adolescents were aware of HIV/AIDS, but only about 30% had knowledge of other STIs. While nearly half understood that a woman could become pregnant after a single instance of sexual intercourse post-puberty, only 5% were informed about the likelihood of a woman's fertile period occurring mid-cycle [15]. This knowledge deficit is closely linked to poor reproductive health outcomes, including high rates of adolescent pregnancy and underutilization of sexual and reproductive health services [16].

Social networks, including friends, family, teachers, and health professionals, play a critical role in shaping adolescents' health knowledge and behaviors [17]. These networks serve as primary sources of information, guidance, and support during the complex developmental period of adolescence. Friends, for instance, often influence behaviors and attitudes related to puberty and sexuality [16]-[20], while family members, particularly parents, provide foundational knowledge and values regarding reproductive health [21], [22]. Teachers and health professionals are equally important, as they are positioned to deliver accurate, evidence-based information and correct any misconceptions adolescents may have [5], [23].

Understanding the role of these social networks is vital for enhancing the effectiveness of reproductive health education. By leveraging the influence of peers, educators, and healthcare providers, reproductive health programs can be more tailored to meet adolescents' needs. Studies show that when adolescents receive accurate information from trusted social networks, they are more likely to engage in healthy behaviors, such as delaying sexual initiation, using contraception, and seeking appropriate healthcare services [19], [23]. In contrast, when social networks propagate misinformation or reinforce cultural taboos, adolescents are left vulnerable to risky behaviors, further underscoring the importance of integrating social networks into comprehensive reproductive health education strategies. To the best of our knowledge, there was limited evidence on the effectiveness of social networks in promoting adolescent puberty knowledge in Indonesia. Previous studies primarily focused on the impact of sexual and reproductive health (SRH) media delivery or comprehensive sexuality education curricula [24]-[26]. This study sought to address this gap by examining the key influencers of adolescent puberty knowledge and assessing the future potential of these social networks in promoting adolescent health in Indonesia.

2. METHOD

2.1. Study population

The present study utilized data from the 2017 Indonesia Demographic and Health Survey (IDHS), a cross-sectional survey conducted by the Indonesian Statistics Board, the National Population and Family Planning Board, and the Ministry of Health as part of the global Demographic and Health Surveys (DHS) Program. The 2017 IDHS employed a two-stage stratified sampling design. In the first stage, census blocks were selected systematically with probability proportional to size, based on the 2010 population census. These blocks were stratified by urban and rural areas and categorized according to wealth index. In the second stage, 25 households were systematically selected from each chosen census block. The sampling design aimed to provide estimates at both the national and provincial levels, including for the adolescent sub-sample. The survey covered a total of 1,970 census blocks across urban and rural regions. Of the 47,963 households successfully interviewed, 10,691 unmarried females aged 15-24 and 13,079 unmarried males aged 15-24 participated in the survey. Thus, the adolescent sub-sample of the 2017 IDHS included 23,770 individuals, comprising both males and females. The current analysis specifically focused on 23,361 respondents who underwent complete case analysis, with missing observations dropped for all variables included in the study.

2.2. Variables and measurements

Dependent variable: The dependent variable in this study was adolescents' knowledge of puberty onset traits, derived from specific questions in the 2017 IDHS that assessed key physical and biological changes during puberty. Respondents' knowledge was evaluated through a series of items that inquired whether they were familiar with these puberty-related characteristics for both boys and girls. The questions posed included: “When a boy begins to enter adolescence, commonly referred to as 'akil baligh' or puberty, he experiences changes in his body. Can you mention those changes?” and “When a girl begins to enter adolescence, she also experiences changes in her body. Can you mention those changes?” Respondents received 1 point for each

correct mention of the following physical and biological changes for boys: (a) muscles start to develop, (b) voice deepens, (c) hair grows on the face, around the genitals, armpits, chest, legs, or arms, (d) increased sexual desire, (e) wet dreams, and (f) the Adam's apple becomes prominent. For girls, the correct responses included: (g) hair grows around the genitals or armpits, (h) breasts enlarge, (i) hips widen, (j) increased sexual desire, and (k) menstruation begins. The scores were categorized to determine whether respondents exhibited good (above the median value) or poor (below the median value) knowledge of puberty onset traits, establishing the outcome variable for subsequent analysis.

Independent variable: The independent variable in this study was the discussion partner for sexuality issues. This variable was based on respondents' answers to questions regarding whom they had discussed topics such as puberty changes and reproductive health. The IDHS survey asked: "With whom have you discussed or asked about reproductive health matters? Have you ever talked about these topics with: friends, mother, father, siblings, relatives, teachers, health professionals, or religious leaders?" The responses identified potential discussion partners to assess the influence of various social networks on adolescents' knowledge of puberty traits. Each discussion partner was categorized as a binary variable (yes or no) to indicate whether or not the respondent had discussed sexuality or reproductive health topics with that individual.

Covariates: This study incorporated several sociodemographic characteristics as covariates in the multivariable model, including age, gender, wealth index, type of residence, and educational level. Age was classified into two categories: 15-19 and 20-24 years, based on the classification used by Statistics Indonesia (*Badan Pusat Statistik*; BPS) [27]. Gender was categorized as male or female. The wealth index was adjusted for rural areas and divided into five categories: poorest, poorer, middle, richer, and richest. The type of residence was categorized as either urban or rural. The highest level of education attained was classified into primary, junior high school, senior high school, academy, and university. All categorizations adhered to Demographic and Health Surveys (DHS) guidelines [28].

2.3. Statistical analysis

Descriptive statistics were presented as frequencies and percentages, as all variables were categorical. The distribution of respondents based on their discussion partners for sexuality topics and their knowledge of puberty onset traits was evaluated using Chi-square tests. A multiple logistic regression model was employed to assess the relationship between discussion partners and knowledge of puberty onset traits. The results were reported as adjusted odds ratios with 95% confidence intervals (CIs). Statistical significance was determined at a threshold of $p<0.05$. Following DHS guidelines, all analyses accounted for the complex sampling design, which involved a two-stage stratified sampling approach. Data analysis was performed using Stata Statistical Software (Version 18: StataCorp LLC).

3. RESULTS AND DISCUSSION

After excluding cases with missing values due to incomplete observations, a complete case analysis was performed on a sample of 23,361 respondents. Table 1 outlines the distribution of respondents according to various sociodemographic characteristics. The majority of participants were between the ages of 15 and 19, representing 64.2% of the total sample. Males comprised a slightly larger proportion than females, accounting for 55.8% of the respondents. The wealth index was relatively evenly distributed, with the richest quintile being the most represented at 21.8%. Urban residents constituted 56.5% of the sample, and the predominant educational level was senior high school, encompassing 60.0% of the respondents.

The analysis indicates that friends are the most frequently consulted discussion partners on sexuality issues, with 55.8% of respondents identifying them as a primary source of information. Teachers follow closely, with 44.3%, highlighting the important role of adolescent social networks in shaping knowledge and providing guidance on sexual health. A clear gendered pattern emerges in parental involvement, as 29.4% of respondents reported discussing sexuality with their mothers, compared to only 6.5% with their fathers. Health service providers, siblings, and relatives also play moderate roles in these discussions, while religious leaders are the least engaged source of information on sexuality matters, as shown in Figure 1.

Table 2 presents the associations between adolescents' knowledge of puberty onset traits and their choice of discussion partners for sexuality issues. In total, 51.2% of adolescents demonstrated good knowledge of puberty onset traits, while 48.8% exhibited poor knowledge. Notably, adolescents who discussed these topics with friends had the highest level of good knowledge, with 64.2% scoring well. Discussions with mothers and teachers also contributed significantly to knowledge, with 37.8% and 52.2% of adolescents, respectively, demonstrating good understanding. Siblings and relatives also influenced knowledge, with 22.6% and 23.3% of adolescents, respectively, showing good knowledge in these groups. Discussions with health service providers resulted in 24.5% of adolescents displaying good knowledge. In contrast, those who consulted fathers (7.5%) and religious leaders (9.3%) were least likely to exhibit good knowledge of puberty traits.

Table 1. Distribution of respondents by sociodemographic characteristics

Variable	Frequency	Weighted (%)
Age (year)		
15-19	14,999	64.2
20-24	8,362	35.8
Gender		
Female	10,513	44.2
Male	12,848	55.8
Wealth index category		
Poorest	5,603	18.3
Poorer	4,794	19.5
Middle	4,370	19.9
Richer	4,245	20.5
Richest	4,349	21.8
Type of place of residence		
Urban	13,393	56.5
Rural	9,968	43.5
Highest educational level		
Primary	1,568	6.9
Junior high school	3,223	15.3
Senior high school	13,851	60.0
Academy	790	3.3
University	3,929	14.5
Total	23,361	100.0

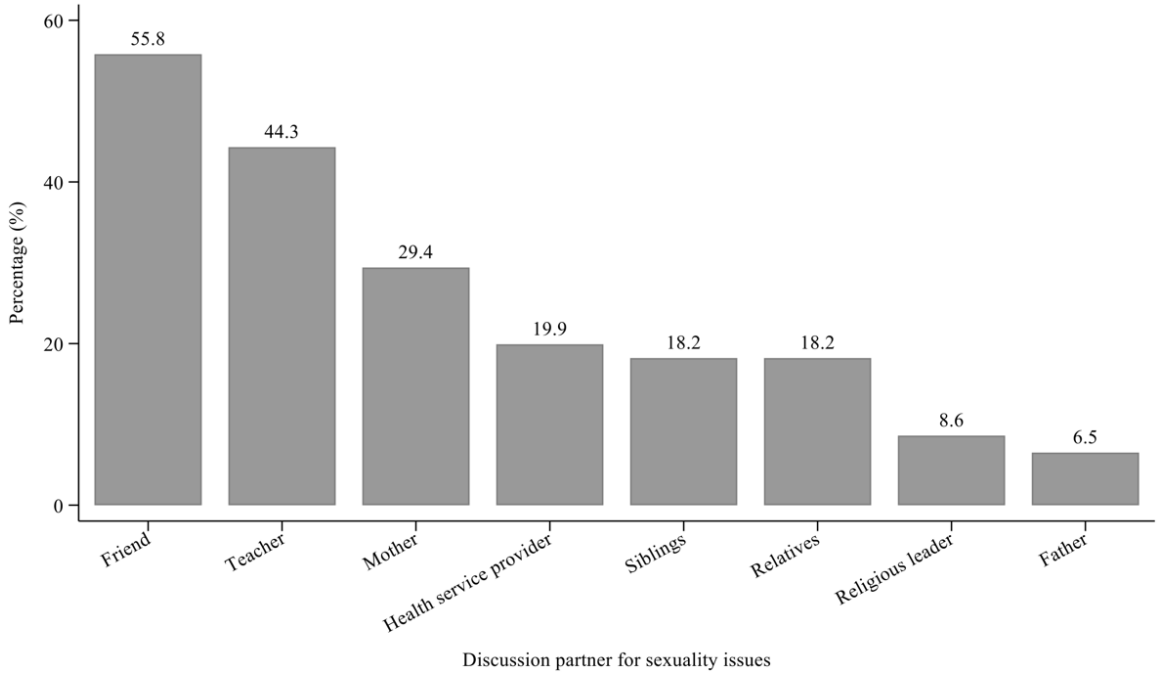

Figure 1. Distribution of adolescent's discussion partner for sexuality issues

The multivariable analysis presented in Table 3 demonstrates that engaging in discussions about sexuality issues is generally associated with improved knowledge of puberty onset traits, though the strength of this association varies across different discussion partners. Notably, conversations with friends (AOR = 1.48; 95% CI = 1.40–1.58; p<0.001), mothers (AOR = 1.33; 95% CI = 1.23–1.44; p<0.001), teachers (AOR = 1.47; 95% CI = 1.39–1.56; p<0.001), and health service providers (AOR = 1.25; 95% CI = 1.16–1.35; p<0.001) were associated with significantly higher levels of adolescent knowledge, even after adjusting for sociodemographic factors, including age, gender, wealth index, place of residence, and education level. Interestingly, while unadjusted models showed significant associations for discussions with fathers, siblings, and religious leaders, these became non-significant after adjusting for confounding factors. In contrast, discussions with relatives retained a modest yet significant positive association (AOR = 1.14; 95% CI = 1.05–1.24; p = 0.002).

Table 2. Distribution of adolescents' knowledge of puberty onset traits based on discussion partner for sexuality issues

Discussion partner for sexuality issues	Knowledge of puberty onset traits			χ^2	p
	Poor (%)	Good (%)	Total (n)		
All	48.8	51.2	23,361		
Friend					
Yes	46.0	64.2	13,134	798.9	<0.001
No	54.0	35.8	10,227		
Mother					
Yes	19.7	37.8	6,690	895.0	<0.001
No	80.3	62.2	16,671		
Father					
Yes	5.4	7.5	1,601	45.3	<0.001
No	94.6	92.5	21,760		
Siblings					
Yes	13.2	22.6	4,451	311.8	<0.001
No	86.8	77.4	18,910		
Relatives					
Yes	12.3	23.3	4,551	475.2	<0.001
No	87.7	76.7	18,810		
Teacher					
Yes	35.3	52.2	10,662	697.6	<0.001
No	64.7	47.8	12,699		
Health service provider					
Yes	14.5	24.5	4,951	336.7	<0.001
No	85.5	75.5	18,410		
Religious leader					
Yes	7.8	9.3	1,847	52.9	<0.001
No	92.2	90.7	21,514		

Table 3. The odds ratios of the association between discussion partner for sexuality issues and adolescents' knowledge of puberty onset traits

Discussion partner for sexuality issues	COR	95% CI	p	AOR*	95% CI	p
Friend	2.13	2.02–2.24	<0.001	1.48	1.40–1.58	<0.001
Mother	2.44	2.30–2.59	<0.001	1.33	1.23–1.44	<0.001
Father	1.42	1.28–1.58	<0.001	0.96	0.85–1.09	0.521
Siblings	1.82	1.70–1.95	<0.001	0.95	0.88–1.04	0.267
Relatives	2.10	1.26–2.25	<0.001	1.14	1.05–1.24	0.002
Teacher	2.02	1.91–2.13	<0.001	1.47	1.39–1.56	<0.001
Health service provider	1.82	1.71–1.94	<0.001	1.25	1.16–1.35	<0.001
Religious leader	1.43	1.30–1.57	<0.001	1.05	0.94–1.17	0.401

COR = Crude Odds Ratio; AOR: Adjusted Odds Ratio

** The AOR was obtained through multiple logistic regression analysis, adjusted for age, gender, wealth index category, type of place of residence, and highest educational level*

The study confirmed the critical role of social networks in shaping adolescents' reproductive health knowledge, particularly highlighting the influence of peer and school environments. Discussions with friends and teachers were identified as the most significant sources of information on puberty and sexuality. These findings underscore the prominence of social contexts outside of the family during adolescence, a developmental period where external influences increasingly shape knowledge and behavior related to reproductive health.

The results suggest that peers and educators play pivotal roles in the dissemination of reproductive health knowledge, reinforcing the importance of school-based interventions and peer-led education programs in promoting adolescent sexual health awareness. Peer education has shown significant positive impacts on adolescent health, as highlighted in various studies [16]-[19]. Peer education was found to effectively enhance emotional and social resilience, allowing young people to better cope with challenges [19]. Another study demonstrated improvements in adolescents' quality of life, especially in areas related to health behaviors, self-efficacy, and mental well-being, following peer-led health education interventions [18]. Additionally, a study from Central India on adolescent-friendly health services revealed that peer education increased awareness and utilization of health services, underscoring its role in bridging gaps between adolescents and healthcare providers [16].

The strong associations between discussions with teachers and improved adolescent understanding of puberty and sexuality support the need for comprehensive sexuality education in schools. Prior studies have consistently demonstrated the positive impact of school-based sexual health education on adolescent knowledge and behavior. For instance, Pinandari *et al.* found that the school-based comprehensive sexuality

education intervention significantly enhances knowledge and attitudes related to healthy sexuality among very young adolescents in urban Indonesia [4]. Another study also emphasized the significant positive impact of school-based sexual health education interventions on adolescents, demonstrating that these programs effectively improve knowledge, attitudes, and behaviors related to healthy sexuality [5]. Similarly, the revised international technical guidance on sexuality education underscored the critical role of school-based sexuality education in equipping young people with essential knowledge and skills, thereby promoting safer sexual practices and ultimately contributing to improved health outcomes for adolescents [29]. These findings emphasize that schools, as formal settings for knowledge dissemination, play a crucial role in shaping reproductive health literacy, reinforcing the argument for standardized, evidence-based sexuality education curricula in educational institutions.

This study also highlighted the role of health service providers in enhancing adolescent health literacy, underscoring the value of integrating healthcare professionals into adolescent health programs. By providing accurate information and addressing misconceptions, healthcare providers can serve as trusted sources of guidance for young people, complementing the education received in schools. Previous research has demonstrated that the involvement of healthcare professionals in reproductive health education can improve their ability to address patients' reproductive health needs effectively, thus increasing adolescents' access to services [23]. Expanding healthcare providers' roles within schools and community-based programs may therefore be an effective strategy to bridge gaps in reproductive health education and ensure comprehensive support for adolescents.

Parental involvement, however, remains a crucial yet underexplored aspect of adolescent reproductive health education. The study identified a distinct gendered pattern in these discussions, with mothers being more frequently engaged than fathers. Fathers, on the other hand, showed significantly lower involvement, and after adjusting for confounding factors, discussions with fathers did not show a significant association with improved knowledge. Prior studies have also highlighted this disparity, suggesting that traditional gender norms often position mothers as the primary communicators of health-related information within the family [30], [31]. Fathers are often perceived as less comfortable or knowledgeable in discussing sensitive topics such as sexuality, resulting in lower engagement [32]-[35]. This reflects traditional caregiving roles, where mothers are expected to address sensitive topics like puberty and sexuality [36]. This gap in paternal involvement could limit the comprehensive nature of adolescent health education, as research shows that when both parents are actively involved, adolescents tend to have a more well-rounded understanding of reproductive health issues [21], [22], [37]. This limited paternal engagement represents a missed opportunity for enhancing adolescent reproductive health knowledge through balanced parental contributions. Encouraging greater paternal involvement in these discussions could diversify the sources of support available to adolescents and strengthen family-based health education.

According to social network theory [38], adolescents are significantly influenced by the behaviors and norms of their social circles, which positions peers as key sources of information. However, parents also play a pivotal role in this dynamic; their involvement can shape attitudes and behaviors related to reproductive health. While teachers and healthcare providers are essential in validating or correcting knowledge and fostering a supportive environment, parents can create a foundation for open communication and provide context for the information that adolescents receive from peers and educators. Social networks, including familial connections, not only disseminate information but also reinforce health-related behaviors, thereby amplifying the effects of interventions.

To effectively leverage these dynamics, it is crucial to enhance parental engagement in reproductive health discussions. Initiatives that educate parents about the importance of their role in their children's sexual health education can improve overall health literacy. Integrating peer-led initiatives and training educators and healthcare providers to communicate effectively can maximize the reach and impact of sexual health programs, ultimately leading to better health outcomes for adolescents. Furthermore, fostering collaboration among these social networks, including parents, peers, teachers, and healthcare providers, can create a comprehensive support system. This collaborative approach ensures that adolescents have access to accurate information and resources when navigating their reproductive health, empowering them to make informed decisions.

While this study sheds light on the pivotal role of social networks in shaping adolescents' reproductive health knowledge, several limitations must be acknowledged. The reliance on self-reported data may introduce biases, as adolescents may underreport or overreport their knowledge and behaviors related to sexual health due to social desirability or fear of judgment. Additionally, the cross-sectional nature of the study limits causal inferences, making it challenging to determine the directionality of relationships among peers, educators, and health service providers. Moreover, the study's focus on specific social networks may overlook other key influences on adolescents, such as cultural norms, socioeconomic factors, and geographic differences, raising concerns about the representativeness of its findings. The gendered dynamics in parental involvement also suggest limited reflection of diverse family structures. Additionally, a lack of sample diversity may hinder the generalizability of the results. Future research should adopt a more comprehensive approach, including

longitudinal studies and varied demographics, to better understand the full range of social influences. Engaging fathers and other adults in sexual health discussions could also improve the effectiveness of interventions.

4. CONCLUSION

In conclusion, this study highlights the critical role of social networks, particularly peers and educators, in shaping adolescents' reproductive health knowledge and underscores the necessity for effective school-based interventions and peer-led education programs to enhance sexual health awareness. The limited involvement of fathers in this study emphasizes the need for greater parental engagement, which can provide adolescents with a more comprehensive understanding of reproductive health issues. Furthermore, integrating healthcare providers into adolescent health programs can support young people's education, creating a collaborative support system among parents, peers, teachers, and healthcare providers that empowers adolescents to make informed decisions about their sexual health.

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Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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Riza Fatma Arifa	✓	✓	✓		✓				✓					
Ratu Matahari		✓		✓	✓				✓	✓				
Syariatul Dirgantara					✓	✓			✓					
Pairote Chakranon		✓							✓	✓				

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The study utilized data from the MEASURE DHS program, which can be accessed publicly upon request. Researchers may obtain the dataset by creating an account and submitting a formal request via the MEASURE DHS portal.

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BIOGRAPHIES OF AUTHORS

Dedik Sulistiawan is an assistant professor in the Department of Public Health at Universitas Ahmad Dahlan, Yogyakarta, Indonesia. He previously served as a researcher at the Center for Health Policy and Management at Universitas Gadjah Mada, Yogyakarta, Indonesia. His research interests include public health policy, community health, and family planning, with a focus on translating evidence-based policies into practice to enhance community health outcomes. He can be contacted at email: dedik.sulistiawan@ikm.uad.ac.id.

Riza Fatma Arifa is a researcher at the National Research and Innovation Agency (*Badan Riset dan Inovasi Nasiona*l; BRIN) Republic of Indonesia. Previously, she worked at the National Population and Family Planning Board (*Badan Kependudukan dan Keluarga Berencana Nasional*; BKKBN). Her primary research interests include population studies and policy. She can be contacted at email: riza.fatma.arifa@gmail.com.

Ratu Matahari is an assistant professor in the Department of Public Health at Universitas Ahmad Dahlan, Yogyakarta, Indonesia. Her research areas include population and social research, reproductive health, gender, and marginalized communities. She can be contacted at email: ratu.matahari@ikm.uad.ac.id.

Syariatul Dirgantara is a Master of Public Health student in the Faculty of Public Health at Universitas Ahmad Dahlan, Yogyakarta, Indonesia. Her research focuses on public health, with particular interests in reproductive health and environmental health issues. She can be contacted at email: at syariatul1700029286@webmail.uad.ac.id.

Pairote Chakranon is a postdoctoral fellow at the School of Public Health, College of Public Health, Taipei Medical University, Taiwan. His research focuses on child health and mental health. He can be contacted at email: d508111006@tmu.edu.tw.