
Association Between Health Promotion Program Participation and Health Knowledge and Health-Promoting Behavior Among Adolescents in Pati Regency, Central Java: A Cross-Sectional Study

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ABSTRACT

Introduction: This study aimed to examine the association between participation in adolescent health-promotion programs and health knowledge and health-promoting behaviors among adolescents in Pati Regency, Central Java.

Methods: A quantitative analytic cross-sectional study was conducted from February to April 2025 across three sub-districts: Kecamatan Pati, Juwana, and Gabus. A total of 207 adolescents aged 13–19 years from six public junior and senior high schools were selected using multistage stratified random sampling. Data were collected using a structured self-administered questionnaire assessing sociodemographic characteristics, participation in Posyandu Remaja or *Pelayanan Kesehatan Peduli Remaja* (PKPR), health knowledge, and health-promoting behaviors. Data were analyzed using descriptive statistics, Chi-square tests, and multivariable binary logistic regression.

Results: Participation in Posyandu Remaja or PKPR was independently associated with adequate health knowledge after adjustment for sociodemographic factors (adjusted OR = 2.89; 95% CI: 1.68–4.97; $p < 0.001$). Participation was also associated with good health-promoting behavior in bivariate analysis (crude OR = 2.74; 95% CI: 1.63–4.60; $p < 0.001$). Reproductive health had the lowest proportion of adequate knowledge (43.0%), whereas physical activity had the highest (73.4%). Female sex was independently associated with adequate health knowledge (adjusted OR = 1.84; 95% CI: 1.09–3.10; $p = 0.023$).

Conclusion: These findings indicate statistical associations between participation in adolescent health-promotion programs and health-related outcomes. Because this was a cross-sectional study and exposure and outcomes were measured simultaneously, temporal sequence and causality cannot be established. The findings support continued strengthening of youth-friendly adolescent health-promotion

Keywords: Smartphone addiction; Anxiety; Adolescents; Mental Health

INTRODUCTION

Adolescence is a critical period of human development characterized by rapid physical, psychological, cognitive, and social changes that can influence health throughout the life course. Globally, adolescents experience multiple health

challenges, including nutritional problems, mental health disorders, non-communicable diseases (NCDs), substance use, injuries, and reproductive health risks (1). Health-related behaviors established during adolescence may persist into adulthood, making this stage an important

opportunity for preventive and promotive health interventions (1). Strengthening access to appropriate health information, adolescent-responsive services, and supportive social environments is therefore essential to promote healthy development and reduce preventable health risks among young people (1).

In Indonesia, adolescents aged 10–19 years constitute a large population group, numbering approximately 46 million (2). Indonesian adolescents continue to face multidimensional health problems, including nutritional deficiencies, mental health problems, reproductive health risks, tobacco and electronic-cigarette use, and behavioral risk factors for NCDs (2). Suicide is also reported among the important causes of adolescent mortality, indicating that adolescent health interventions need to address physical, psychological, and behavioral dimensions simultaneously (2). These conditions highlight the need for comprehensive adolescent health promotion that combines health education, counseling, early detection, peer support, and accessible health services.

The Indonesian government has developed *Pelayanan Kesehatan Peduli Remaja* (PKPR) through primary health centers (*Puskesmas*) and community-based services such as Posyandu Remaja to strengthen adolescent health promotion (5). These programs provide health information, counseling, screening, health education, and opportunities for adolescents to participate in promotive and preventive activities (5). Previous studies indicate that structured health-promotion activities, including peer education, health literacy programs, and community-based adolescent services, are associated with improved health knowledge and healthier behaviors (6,7). However, program effectiveness is influenced by participation, service accessibility, peer support, health literacy, availability of trained cadres, and the quality of program delivery (8–11). Limited program awareness, inadequate

youth-friendly services, insufficient cadre capacity, and weak managerial support have also been identified as barriers to adolescent participation in PKPR and Posyandu Remaja (8,9).

At the provincial level, adolescent health problems remain evident in Central Java. The 2023 Central Java Provincial Health Profile documented continuing challenges related to anemia, nutritional status, and utilization of reproductive health services among adolescents (3). Similar conditions have been reported in Pati Regency. A local study among adolescents aged 13–15 years at SMP Negeri 1 Tayu found that, despite generally adequate nutritional status, inadequate energy and carbohydrate intake occurred in 60% and 67% of respondents, respectively (4). Other local evidence has also reported chronic energy deficiency among female adolescents in Pati Regency (21). These findings indicate that apparently adequate nutritional status does not necessarily correspond to appropriate health knowledge or consistently healthy behavior among adolescents.

Despite the availability of PKPR and Posyandu Remaja, an important scientific gap remains. Previous Indonesian studies have predominantly examined program implementation, barriers to service delivery, adolescent participation, or specific health problems rather than assessing multiple health-knowledge domains and broader health-promoting behaviors simultaneously (7–9,12). Evidence directly comparing adolescents who participate in PKPR or Posyandu Remaja with those who do not participate, while accounting for sociodemographic characteristics, also remains limited. This gap is particularly relevant in Pati Regency because existing local evidence has mainly focused on nutritional problems, whereas evidence regarding the association between participation in adolescent health-promotion programs and broader health knowledge and behaviors is still scarce (4,21). In addition, Pati Regency includes

urban, semi-urban, and rural communities that may differ in access to health information and health-promotion services. District-level evidence is therefore important because planning, resource allocation, cadre development, and strengthening of PKPR and Posyandu Remaja are largely undertaken through Puskesmas and local health authorities.

This study is conceptually guided by Pender's Health Promotion Model, which explains that health-promoting behavior is influenced by individual characteristics and experiences, perceived benefits and barriers, self-efficacy, interpersonal influences, situational influences, and commitment to action (15). Within this framework, participation in PKPR or Posyandu Remaja is conceptualized as an interpersonal and situational influence that increases adolescents' exposure to health information, counseling, health screening, peer interaction, and health professionals (15). Such exposure may be associated with greater health knowledge and may support healthier behavior through increased self-efficacy and perceived benefits of health-promoting actions. Sociodemographic characteristics, including sex, age, school level, parental education, and residence, may also influence both participation and health outcomes. Accordingly, program participation is positioned as the main exposure, health knowledge and health-promoting behaviors as outcomes, and sociodemographic characteristics as potential confounding factors.

Therefore, this study aims to examine the association between participation in Posyandu Remaja or PKPR and health knowledge and health-promoting behaviors among adolescents aged 13–19 years in Pati Regency, Central Java, and to identify sociodemographic factors independently associated with adequate adolescent health knowledge.

METHOD

Research Design

This study employed a quantitative analytic cross-sectional design. This design was used to examine the association between participation in adolescent health-promotion programs and health knowledge and health-promoting behaviors at a single point in time (13). Data were collected using a structured self-administered questionnaire covering sociodemographic characteristics, participation in Posyandu Remaja or Pelayanan Kesehatan Peduli Remaja (PKPR), health knowledge across five domains, and health-promoting behaviors. Because exposure and outcome variables were measured simultaneously, the study was designed to identify statistical associations rather than causal relationships or temporal sequences. Accordingly, causal terms such as "effect," "impact," or "caused by participation" were avoided throughout the interpretation of the findings.

Population and Sample

The study population comprised adolescents aged 13–19 years enrolled in public junior and senior high schools in Pati Regency, Central Java. Participants were eligible if they were aged 13–19 years, had resided in Pati Regency for at least six months, were enrolled in one of the selected schools, and provided written informed assent. For participants younger than 18 years, written parental or guardian consent was additionally required. Adolescents who were absent on the day of data collection or had severe cognitive impairment that prevented independent completion of the questionnaire were excluded.

Sample-size determination was conducted in two stages. At the initial planning stage, the Slovin formula was used because the size of the accessible student population was known, whereas locally specific estimates of the expected association between health-promotion participation and the study outcomes were not available. Using a 5% margin of error, the preliminary minimum sample size was estimated at 196 respondents. After allowing for approximately 10% non-response, the target sample was set at 215 respondents.

Because the primary objective of the study was analytical rather than purely descriptive, sample adequacy was subsequently verified using a two-independent-proportions approach (32). Assuming a 20-percentage-point difference in the proportion of adequate health knowledge between program participants and non-participants (60% vs. 40%), a two-sided α of 0.05, and statistical power of 80%, a minimum of 97 respondents per group, or 194 respondents in total, was required. The final analytic sample consisted of 207 adolescents, including 113 program participants and 94 non-participants, and therefore exceeded the total

minimum sample requirement. The multivariable logistic regression model included six predictors and 87 observations in the less frequent outcome category, corresponding to approximately 14.5 outcome events per predictor, which exceeded the commonly cited minimum of 10 events per variable (30).

A multistage stratified random sampling procedure was applied across three sub-districts and six public schools. Kecamatan Pati, Kecamatan Juwana, and Kecamatan Gabus were selected to represent urban, semi-urban, and rural settings, respectively, where active PKPR services and Posyandu Remaja activities were available. Sampling was conducted in three stages. First, the three sub-districts were selected to represent different geographic settings within Pati Regency. Second, within each sub-district, one public junior high school and one public senior high school were randomly selected by lottery from the list of public schools provided by the district education office, resulting in six participating schools. Third, the sampling frame within each selected school consisted of the official enrollment list of students aged 13–19 years who met the eligibility criteria. The required number of respondents was allocated proportionally according to the number of eligible students in each sub-district and school level, and individual students were selected using simple random sampling based on computer-generated random numbers. Because proportional allocation and random selection were applied within each stratum, eligible students in the selected schools had approximately equal probability of Research Location

Data collection took place in Pati Regency (Kabupaten Pati), Central Java Province, Indonesia, from February to April 2025. Pati Regency was selected for its urban and semi-urban communities, presence of active PKPR services at multiple Puskesmas, and availability of Posyandu Remaja in selected villages.

Instrumentation or Tools

A structured self-administered questionnaire was used to assess sociodemographic characteristics, participation in adolescent health-promotion programs, health knowledge, and health-promoting behaviors. The questionnaire was developed with reference to instruments previously used in adolescent health research and to the Health-Promoting Lifestyle Profile II (HPLP-II) framework (6,14).

Participation in adolescent health-promotion programs was treated as a binary exposure variable. Respondents were classified as participants if they reported attending at least one Posyandu Remaja or Pelayanan Kesehatan Peduli Remaja (PKPR) activity during the preceding 12 months. Activities

included health screening, counseling, health-education sessions, and peer-educator activities. Posyandu Remaja and PKPR were analyzed as a single exposure variable because, in the study setting, both programs were coordinated by Puskesmas adolescent-health personnel and provided overlapping services, particularly health screening, counseling, and health education. The questionnaire did not record attendance frequency, duration of participation, number of sessions attended, or the intensity and quality of program exposure. Therefore, occasional and repeated participation could not be distinguished, and dose-response relationships could not be assessed.

Health knowledge was assessed using 20 multiple-choice items covering five domains: reproductive health, nutrition, mental health, physical activity, and prevention of non-communicable diseases. Each correct response contributed one point to an overall score ranging from 0 to 20. The total score was expressed as a percentage of the maximum possible score and categorized as adequate when respondents obtained at least 60% of the total score, equivalent to at least 12 correct answers, and inadequate when the score was below 60%. The 60% threshold was based on Bloom's cut-off classification (31).

Health-promoting behavior was assessed using a 15-item instrument adapted from selected HPLP-II items (14,33). The original HPLP-II contains 52 items distributed across six domains: health responsibility, physical activity, nutrition, spiritual growth, interpersonal relations, and stress management. In this study, 15 items were selected to represent five domains considered relevant to adolescents and to PKPR and Posyandu Remaja activities: physical activity, nutrition, health responsibility, stress management, and interpersonal relations, with three items representing each domain. The spiritual-growth domain was omitted to reduce respondent burden. Each item was rated on a four-point Likert scale ranging from 1 = never to 4 = routinely, producing a total score ranging from 15 to 60. Respondents with total scores at or above the sample median were categorized as having good health-promoting behavior.

The selected HPLP-II items underwent a forward-backward translation procedure (28). Two bilingual translators independently translated the selected items into Bahasa Indonesia. The two translations were reconciled into a single Indonesian version, which was then back-translated into English by a third bilingual translator. Discrepancies between the original and back-translated versions were reviewed by the research team, and item wording was adjusted to improve clarity and appropriateness for the adolescent context.

Content validity was evaluated by three experts: a public-health lecturer specializing in health promotion, a nursing lecturer specializing in adolescent and community health, and a PKPR program coordinator from a Puskesmas in Pati Regency. Each expert rated item relevance using a four-point scale from 1 = not relevant to 4 = highly relevant. Item-level content validity was assessed using the Item-Level Content Validity Index (I-CVI), while scale-level content validity was assessed using the Scale-Level Content Validity Index based on the average method (S-CVI/Ave) (26,27). Items were retained when all three experts rated them as 3 or 4, corresponding to an I-CVI of 1.00. An S-CVI/Ave of at least 0.90 was considered excellent. Items not meeting the criterion were revised on the basis of expert comments regarding relevance, wording, clarity, and cultural appropriateness and were subsequently re-evaluated.

Face validity was assessed among 30 adolescents who were not included in the main study sample. Participants were asked to evaluate the clarity and comprehensibility of the questionnaire, and ambiguous wording was simplified before the final instrument was administered. All retained items achieved an I-CVI of 1.00, resulting in an S-CVI/Ave of 1.00 for both the knowledge and health-promoting behavior sections. All retained items also showed corrected item-total correlations of $r \geq 0.30$ in the pilot data. Internal consistency was acceptable, with Cronbach's $\alpha = 0.79$ for the knowledge section and $\alpha = 0.82$ for the health-promoting behavior section. These findings provide evidence of content validity and internal consistency; however, construct validity was not evaluated through factor analysis

I would use “adapted from selected HPLP-II items” rather than simply “adapted HPLP-II,” because only 15 of 52 items were used and one domain was omitted. I would also avoid saying the pilot test “confirmed validity”; the manuscript supports content validity, face validity, item-total correlation performance, and internal consistency, but not construct validity. Finally, do not add a minimum–maximum item-total original pilot data.

Data Collection Procedures

Data collection was conducted over six weeks by four trained research assistants (minimum bachelor's degree in public health or nursing). Assistants visited each school on pre-scheduled dates. Sessions lasted 45–60 minutes. Written informed assent and parental consent were obtained prior to data collection. Questionnaires with >20% missing data were excluded.

Data Analysis

Data were analyzed using SPSS version 26.0

(IBM Corp., Armonk, NY). Descriptive statistics were used to summarize sociodemographic characteristics, health-promotion program participation, health knowledge, and health-promoting behavior. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations where appropriate.

Bivariate associations between participation in Posyandu Remaja/PKPR and categorical study outcomes were examined using the Chi-square test. These outcomes included adequate health knowledge and good health-promoting behavior. Crude odds ratios (ORs) with 95% confidence intervals (95% CIs) were calculated to quantify the magnitude of these unadjusted associations.

Multivariable binary logistic regression was performed with adequate health knowledge as the dependent variable. Health-promotion program participation was included as the primary exposure variable, while sex, age group, school level, parental education, and residence were included as covariates. Variables with $p < 0.25$ in bivariate analysis were considered for inclusion in the multivariable model (29). Age group, school level, and residence were retained regardless of their bivariate p -values because they were considered theoretically relevant potential confounders based on Pender's Health Promotion Model and previous literature. All covariates were entered simultaneously using the enter method.

Multicollinearity among independent variables was assessed using variance inflation factor (VIF) and tolerance statistics, with $VIF > 5$ considered indicative of potentially problematic multicollinearity. Particular attention was given to age group and school level because of their conceptual overlap. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test, with $p > 0.05$ interpreted as indicating no evidence of poor fit. Overall model performance was additionally summarized using Nagelkerke R^2 and classification accuracy (29).

Adjusted odds ratios (AORs) with 95% CIs were reported for the multivariable logistic regression model. The association between health-promotion program participation and health-promoting behavior was assessed only at the bivariate level and was therefore reported as a crude OR rather than an adjusted association. All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

Ethical Approval

Ethical approval was obtained from the Health Research Ethics Committee (KEPK) of STIKES Bakti Utama Pati (Approval No. 027/KEPK/STIKES-BUP/2025, January 20, 2025). All participants provided written informed assent;

parental consent was additionally obtained for participants under 18 years. Data were stored anonymously throughout the study

A total of 150 respondents completed the questionnaires; their characteristics are presented in Table 1. All respondents were enrolled in the Nursing program (see Population and Sample, above).

Regarding smartphone addiction, 56.7% of respondents ($n = 85$) showed moderate addiction, 25.3% ($n = 38$) showed high addiction, and 18.0% ($n = 27$) showed low addiction (Table 2). The mean smartphone addiction score was 34.2 ($SD = 8.7$) on a possible range of 10–60.

Regarding anxiety, 50.8% of respondents experienced anxiety ranging from mild to A total of 215 questionnaires were distributed, of which 210 were returned. Among these, 207 met the inclusion criteria and were included in the analysis, yielding a response rate of 96.3%. Three questionnaires were excluded because more than 20% of the data were missing. The sociodemographic characteristics of the respondents are presented in Table 1. Most respondents were female (56.0%), with a mean age of 15.8 ± 1.6 years. A total of 113 respondents (54.6%) reported participation in Posyandu Remaja or PKPR, while 94 respondents (45.4%) reported no participation.

Table 1. Sociodemographic Characteristics of Adolescent Respondents ($n = 207$)

Characteristic	Category	n	%
Sex	Female	116	56.0
	Male	91	44.0
Age group	13–15 years	112	54.1
	16–19 years	95	45.9
School level	Junior High School	105	50.7
	Senior High School	102	49.3
Residence	Urban (Kec. Pati)	78	37.7
	Semi-urban (Kec. Juwana)	69	33.3
	Rural (Kec. Gabus)	60	29.0
Parental education	≤ Junior High School	88	42.5
	≥ Senior High School	119	57.5
HP program participation	Yes (Posyandu Remaja/PKPR)	113	54.6
	No	94	45.4

HP: Health promotion. Source: Primary data, 2025.

RESULT

Health knowledge was evaluated across five domains. Reproductive health showed the lowest proportion of respondents with adequate knowledge, with 89 respondents (43.0%) meeting the adequacy criterion. Nutrition and diet knowledge was adequate among 114 respondents (55.1%), while adequate mental health and stress knowledge was identified in 106 respondents (51.2%). Physical activity showed the highest proportion of adequate knowledge, with 152 respondents (73.4%), whereas 109 respondents (52.7%) demonstrated adequate knowledge regarding prevention of non-communicable diseases. Overall, 120 respondents (58.0%) were classified as having adequate health knowledge based on the $\geq 60\%$ threshold described in the Methods section.

Table 2. Adequate Health Knowledge by Domain Among Adolescent Respondents ($n = 207$)

Knowledge Domain	Adequate Knowledge, n (%)	Inadequate Knowledge, n (%)
Reproductive health	89 (43.0)	118 (57.0)
Nutrition and diet	114 (55.1)	93 (44.9)
Mental health and stress	106 (51.2)	101 (48.8)
Physical activity	152 (73.4)	55 (26.6)
NCD prevention	109 (52.7)	98 (47.3)
Overall knowledge	120 (58.0)	87 (42.0)

Knowledge adequacy was defined using the $\geq 60\%$ criterion described in the Methods section. NCD: non-communicable disease. Source: Primary data, 2025.

Bivariate analysis showed that adolescents who participated in Posyandu Remaja or PKPR had higher odds of having adequate health knowledge compared with non-participants ($OR = 3.12$; 95% CI: 1.87–5.21; $p < 0.001$). Participation was also associated with higher odds of reporting good health-promoting behavior ($OR = 2.74$; 95% CI: 1.63–4.60; $p < 0.001$). These results represent unadjusted associations and do not establish that participation caused higher health knowledge or better health-promoting behavior.

Table 3. Association Between Health Promotion Participation and Adolescent Health Outcomes (n = 207)

Outcome	Program Participation	Outcome Present, n (%)	Outcome Absent, n (%)	Crude OR (95% CI)	p-value
Adequate health knowledge	Yes (n = 113)	81 (71.7)	32 (28.3)	3.12 (1.87–5.21)	<0.001
	No (n = 94)	39 (41.5)	55 (58.5)	Reference	
Good health-promoting behavior	Yes (n = 113)	79 (69.9)	34 (30.1)	2.74 (1.63–4.60)	<0.001
	No (n = 94)	41 (43.6)	53 (56.4)	Reference	

OR: Odds ratio. Source: Primary data, 2025.

Multivariable logistic regression was used to examine factors independently associated with adequate health knowledge. After adjustment for sex, age group, school level, parental education, and residence, participation in Posyandu Remaja or PKPR remained independently associated with adequate health knowledge (adjusted OR = 2.89; 95% CI: 1.68–4.97; $p < 0.001$). Female respondents also had higher adjusted odds of adequate health knowledge compared with male respondents (adjusted OR = 1.84; 95% CI: 1.09–3.10; $p = 0.023$).

Age group (adjusted OR = 1.47; 95% CI: 0.88–2.45; $p = 0.141$), school level (adjusted OR = 1.31; 95% CI: 0.76–2.26; $p = 0.334$), parental education (adjusted OR = 1.56; 95% CI: 0.93–2.62; $p = 0.093$), and residence (adjusted OR = 1.22; 95% CI: 0.71–2.10; $p = 0.471$) were not statistically significantly associated with adequate health knowledge after adjustment. The model had a Nagelkerke R^2 of 0.28. Because the exposure and outcome were measured simultaneously, these adjusted associations do not establish temporal sequence or causality, and reverse causality cannot be excluded.

Table 4. Multivariable Logistic Regression for Adequate Health Knowledge (n = 207)

Variable	Adjusted OR	95% CI	p-value
HP participation (Yes vs. No)	2.89	1.68–4.97	<0.001
Sex (Female vs. Male)	1.84	1.09–3.10	0.023
Age (16–19 vs. 13–15 years)	1.47	0.88–2.45	0.141
School level (SHS vs. JHS)	1.31	0.76–2.26	0.334

Parental education ($\geq$ SHS vs. $\leq$ JHS)	1.56	0.93–2.62	0.093
Residence (semi-urban/rural vs. urban)	1.22	0.71–2.10	0.471

HP: Health promotion; SHS: Senior High School; JHS: Junior High School; OR: Odds Ratio; Nagelkerke $R^2 = 0.28$. Source: Primary data, 2025.

DISCUSSION

The main finding of this study was that participation in Posyandu Remaja or PKPR was independently associated with adequate health knowledge after adjustment for sex, age group, school level, parental education, and residence. Adolescents who participated had higher adjusted odds of adequate health knowledge than non-participants (adjusted OR = 2.89; 95% CI: 1.68–4.97). Participation was also associated with good health-promoting behavior in the bivariate analysis (crude OR = 2.74; 95% CI: 1.63–4.60). These findings are consistent with Pender's Health Promotion Model, which emphasizes the role of perceived benefits, self-efficacy, interpersonal influences, and situational factors in shaping health-promoting behavior (15). Participation in structured adolescent health programs may increase exposure to health information, counseling, peer interaction, and health services, which may be associated with better health knowledge and healthier behavior. However, because the study used a cross-sectional design, the temporal sequence between participation and outcomes cannot be established. It is therefore also possible that adolescents with greater prior health knowledge or stronger health awareness were more likely to participate in Posyandu Remaja or PKPR.

The distribution of knowledge across health domains provides additional context for the overall findings. Reproductive health showed the lowest proportion of adequate knowledge, with 43.0% of respondents meeting the adequacy criterion, whereas physical activity showed the highest proportion at 73.4%. The relatively low level of reproductive health knowledge is consistent

with previous Indonesian studies reporting persistent barriers to adolescent reproductive health information, including sociocultural sensitivity and limited access to appropriate information (16,17). In contrast, the higher level of physical activity knowledge may reflect greater exposure to physical activity content through school-based education and routine health messaging. These findings indicate that reproductive health, mental health, and prevention of non-communicable diseases represent important areas for strengthening adolescent health education within PKPR and Posyandu Remaja.

The present findings are broadly consistent with previous studies of adolescent health promotion in Indonesia. Ispriantari et al. reported that self-efficacy and social support were important factors associated with health-promoting behaviors among Indonesian adolescents living in child welfare institutions (6). Previous community-based work has also reported favorable changes in health literacy and life skills in relation to participatory adolescent health activities (18). At the national level, the UNICEF Indonesia adolescent health profile emphasized the importance of adolescent-friendly services and service quality in supporting engagement with adolescent health programs (2). Taken together, these studies support the relevance of interpersonal support, accessible health information, and youth-friendly services in adolescent health promotion.

Female sex was independently associated with adequate health knowledge in the adjusted model (adjusted OR = 1.84; 95% CI: 1.09–3.10; $p = 0.023$). This finding is consistent with previous Indonesian research showing gender-related differences in adolescent reproductive health behavior and health-information seeking (16,17). One possible explanation is that female adolescents may have greater exposure to or interest in health information, particularly on topics such as menstruation, anemia prevention, and

reproductive health. PKPR and related adolescent health activities may also include content that is particularly relevant to female adolescents. However, information-seeking behavior, topic-specific exposure, and differential program content by sex were not measured in the present study. These explanations should therefore be regarded as plausible hypotheses rather than confirmed mechanisms. Further research is needed to determine which factors account for the observed difference in health knowledge between female and male adolescents.

Parental education and residence were not statistically significantly associated with adequate health knowledge after adjustment. Although socioeconomic and geographic characteristics may influence access to health information and services, the present study cannot determine why these associations were not observed. One possible explanation is that adolescent health information and services may have been relatively accessible across the selected study locations, thereby reducing differences between urban, semi-urban, and rural respondents. However, service accessibility, intensity of program exposure, and other socioeconomic factors were not directly measured; therefore, this interpretation remains tentative.

Several limitations should be considered when interpreting the findings. First, the cross-sectional design does not establish temporal sequence or causality, and reverse causality cannot be excluded. Second, participation in Posyandu Remaja or PKPR was self-reported and may have been affected by recall or social desirability bias. Third, the study was conducted in six public schools across three sub-districts of Pati Regency, which limits generalizability to adolescents attending other schools or those outside formal education. Fourth, health-promoting behavior was assessed through self-report rather than objective measures, which may introduce measurement bias. Fifth, frequency, duration, and intensity of program participation were not

measured; therefore, occasional and repeated participation could not be distinguished, and dose-response relationships could not be evaluated. Sixth, Posyandu Remaja and PKPR were analyzed as a combined exposure, preventing separate assessment of the association of each program with the study outcomes. Finally, instrument validation included content validity, face validity, item-total correlation, and internal consistency, but construct validity was not evaluated through factor analysis.

Future studies should use longitudinal, prospective, or quasi-experimental designs to clarify temporal relationships and assess whether participation in adolescent health-promotion programs precedes changes in health knowledge and behavior. Future research should also distinguish between Posyandu Remaja and PKPR, measure the frequency and duration of participation, and assess specific program components such as peer education, counseling, digital health literacy, and school-based activities. Additional investigation of sex-specific barriers, health-information-seeking behavior, and differences in program exposure may also help explain the observed variation in adolescent health knowledge.

CONCLUSION

The findings of this cross-sectional study indicate that participation in Posyandu Remaja or PKPR was independently associated with adequate health knowledge after adjustment for sociodemographic factors (adjusted OR = 2.89; 95% CI: 1.68–4.97; $p < 0.001$). Participation was also associated with good health-promoting behavior in bivariate analysis (crude OR = 2.74; 95% CI: 1.63–4.60; $p < 0.001$). Female sex was independently associated with adequate health knowledge (adjusted OR = 1.84; 95% CI: 1.09–3.10; $p = 0.023$). Reproductive health represented the most prominent knowledge gap, while mental health and non-communicable disease prevention also remained important areas for

adolescent health education.

Because exposure and outcomes were measured simultaneously, these findings represent statistical associations and do not establish temporal sequence or causality. The observed association between female sex and adequate health knowledge should also not be interpreted as evidence of a specific mechanism, because factors such as health-information-seeking behavior and differential exposure to program content were not measured in this study.

Within these limitations, the findings support the continued strengthening of adolescent health-promotion services in Pati Regency through youth-friendly service delivery, peer-support activities, cadre capacity building, and integration with school-based health programs. Future longitudinal and intervention-based studies are needed to clarify causal pathways, distinguish the specific contributions of Posyandu Remaja and PKPR, and evaluate how participation intensity and program content relate to adolescent health knowledge and behavior.

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