

# Analysis of factors related to adolescents' quality of life and health in North Minahasa Regency

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## ABSTRACT

**Background:** Adolescence is a critical developmental stage marked by physical, psychological, and social changes that influence long-term health outcomes. Various behavioral and health-related factors may affect adolescents' quality of life; however, evidence from regional settings in Indonesia remains limited.

**Objective:** To analyze factors associated with adolescents' quality of life and health in North Minahasa Regency.

**Methods:** A school-based cross-sectional study was conducted among 427 adolescents aged 13–18 years recruited from eight randomly selected junior and senior high schools in North Minahasa Regency, Indonesia, between November 2023 to February 2024. Sample size was calculated using a single population proportion formula with a 95% confidence level and 5% margin of error. Data were collected using validated Indonesian versions of the WHOQOL-BREF, Pittsburgh Sleep Quality Index (PSQI), and Global School-based Student Health Survey (GSHS). Quality-of-life scores were transformed according to WHO guidelines and categorized using median-based cut-off values. Chi-square tests were performed for bivariate analyses. Variables with  $p < 0.25$  were entered into multivariable logistic regression models. Separate logistic regression analyses were conducted for physical, psychological, social, and environmental quality-of-life domains. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were reported.

**Results:** Poor nutritional status was independently associated with poorer physical (AOR=1.85; 95%CI:1.12–3.04),

psychological (AOR=2.10; 95%CI:1.35–3.26), and environmental quality of life (AOR=1.76; 95%CI:1.07–2.89). Smoking behavior was associated with poorer physical (AOR=1.62; 95%CI:1.05–2.50) and psychological quality of life (AOR=1.94; 95%CI:1.15–3.28). Alcohol consumption significantly increased the likelihood of poor physical quality of life (AOR=2.25; 95%CI:1.45–3.49). Poor sexual and reproductive health was associated with lower quality of life in physical, psychological, and environmental domains. Female gender and poor physical activity were independently associated with poorer psychological well-being.

**Conclusion:** Adolescents' quality of life in North Minahasa is influenced by multiple behavioral and health-related factors, particularly nutritional status, smoking, alcohol consumption, physical activity, and reproductive health. Comprehensive school-based and community-based interventions are necessary to improve adolescent well-being.

## KEYWORDS

Adolescent; Health-Related Quality of Life; Health Behavior; Risk Behavior; Psychological Well-Being

## INTRODUCTION

Adolescence is a critical developmental stage characterized by rapid physical, psychological, and social changes that significantly influence health outcomes throughout the life course. During this period, adolescents begin to establish lifestyle behaviors that may persist into adulthood, making adolescent health a global public health priority. Health-related quality of life (HRQoL) has become an important indicator used to assess adolescents' well-being because it reflects individuals' perceptions of their physical health, psychological condition, social relationships, and environmental circumstances<sup>1</sup>. Globally, many adolescents face health challenges

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such as unhealthy dietary patterns, sedentary lifestyles, substance use, and mental health problems, which may negatively affect their quality of life<sup>2,3</sup>.

Previous studies have demonstrated that lifestyle behaviors play a significant role in shaping adolescents' health and well-being. Nutritional status, physical activity, smoking behavior, and alcohol consumption have been widely recognized as important determinants of adolescents' quality of life<sup>4-6</sup>. In addition, poor sleep quality and excessive screen time have been associated with reduced psychological well-being, emotional instability, and lower life satisfaction among adolescents<sup>7,8</sup>. These findings suggest that adolescents' quality of life is influenced by multiple behavioral and environmental factors that interact in complex ways.

Beyond lifestyle behaviors, sexual and reproductive health is also an important component of adolescent well-being. Limited knowledge and inadequate access to reproductive health information may increase adolescents' vulnerability to risky behaviors such as early sexual activity, unintended pregnancy, and sexually transmitted infections<sup>2,9</sup>. Furthermore, several studies have highlighted the influence of social environments, family relationships, and school climate on adolescents' psychological well-being and overall quality of life<sup>10</sup>. These factors highlight the need for comprehensive approaches that consider multiple determinants of adolescent health and well-being.

Despite the growing body of international literature on adolescent health, evidence from developing countries, particularly at the regional level, remains limited. In Indonesia, adolescents represent a substantial proportion of the population, yet studies examining determinants of adolescents' quality of life are still relatively scarce. Most previous research has focused on individual risk behaviors or specific health outcomes rather than examining multiple behavioral and health-related determinants simultaneously. In addition, limited research has explored adolescents' quality of life in specific regional contexts such as North Minahasa Regency, where rapid social and lifestyle changes may influence adolescents' health behaviors and well-being.

Therefore, there remains an important research gap in understanding how various lifestyle behaviors and health-related factors collectively influence adolescents' quality of life in regional settings. Addressing this gap is essential for developing effective adolescent health promotion programs and evidence-based policies. The novelty of this study lies in its comprehensive analysis of multiple determinants—including nutritional status, smoking behavior, alcohol consumption, physical activity, sleep quality, and sexual and reproductive health—using standardized international instruments (WHOQOL-BREF, PSQI, and GSHS). By focusing on adolescents in North Minahasa Regency, this study provides new empirical evidence from an underrepresented regional context and contributes to the

growing body of global literature on adolescent health and well-being.

## METHODS

This study used an analytical observational design with a cross-sectional approach to assess factors related to the quality of life of adolescents in North Minahasa Regency, Indonesia. The study was conducted between November 2023 and February 2024 in several junior high schools and senior high schools located in North Minahasa Regency. The study population consisted of adolescents aged 13–18 years who were enrolled in junior high schools and senior high schools in North Minahasa Regency during the study period. Schools eligible for inclusion were identified through the regional education office database. From the list of eligible schools, schools were selected using a simple random sampling procedure. Furthermore, students meeting the inclusion criteria were randomly selected from the school attendance lists. The sample size was calculated using the formula for a cross-sectional study:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Using a 95% confidence level ( $Z=1.96$ ), estimated prevalence of 50%, and margin of error of 5%, the minimum required sample size was 384 participants. After adding 10% to compensate for incomplete responses, the final target sample was 422 participants. A total of 427 adolescents were successfully recruited from 8 schools that were selected using a simple random sampling method and were included in the final analysis.

Inclusion criteria included adolescents aged 13–18 years who were actively enrolled in participating schools and willing to participate in the study. Adolescents with incomplete questionnaires, absence during data collection, or refusal to participate were excluded from the study.

Data were collected using standardized and validated questionnaires, including:

1. WHOQOL-BREF Indonesian version to assess quality of life across four domains (physical, psychological, social, and environmental);
2. Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality;
3. Global School-based Student Health Survey (GSHS) to assess adolescent health behaviors and risk factors.

The Indonesian versions of these instruments have previously demonstrated acceptable validity and reliability in adolescent populations. Quality-of-life scores obtained from WHOQOL-BREF were transformed according to WHO scoring guidelines and categorized into "good" and "poor" quality of life using median-based cut-off points for each domain. Nutritional status was assessed using body mass

index-for-age (BMI-for-age) based on WHO adolescent growth standards and categorized into normal and poor nutritional status, where poor nutritional status included undernutrition and overweight/obesity categories. Physical activity was classified according to WHO recommendations for adolescents. Participants engaging in less than 60 minutes of moderate-to-vigorous physical activity per day were categorized as having poor physical activity. Sexual and reproductive health was assessed using structured questions adapted from GSHS components, including knowledge, attitudes, and risk-related behaviors. Scores below the median value were categorized as poor sexual and reproductive health. Health risk behavior was constructed as a composite variable including smoking behavior, alcohol consumption, and other risky adolescent behaviors identified through the questionnaire.

Data were analyzed using IBM SPSS Statistics version XX. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. Associations between independent variables and quality-of-life domains were initially assessed using Chi-square tests.

Variables with  $p$ -values  $<0.25$  in bivariate analyses were entered into multivariable logistic regression models. Separate logistic regression models were developed for each WHOQOL-BREF domain (physical, psychological, social, and environmental) as dependent variables. The enter method was used for variable inclusion.

Multicollinearity among independent variables was assessed using Variance Inflation Factors (VIFs), and no significant multicollinearity was detected (all VIF values  $<5$ ). Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test, which demonstrated acceptable fit for all models ( $p>0.05$ ). Pseudo- $R^2$  statistics (Nagelkerke  $R^2$ ) ranged from 0.18 to 0.31, indicating moderate explanatory power.

Adjusted odds ratios (AORs) and 95% confidence intervals were reported. Statistical significance was established at  $p<0.05$ .

## RESULTS

A total of 427 adolescents participated in this study. The majority of respondents were in the middle adolescence age group (69.8%), followed by early adolescence (29.5%), while only a small proportion were categorized as late adolescents (0.7%). In terms of gender, females accounted for the majority of participants (59.3%), whereas males represented 40.7% of the sample. Most respondents were enrolled in senior high school (69.1%), while 30.9% were junior high school students.

Regarding health-related characteristics, the findings revealed that a large proportion of adolescents had poor nutritional status (63.7%). Similarly, most respondents reported

**Table 1.** Sociodemographic Characteristics of Respondents

| Variable                  | Category                                     | n   | %    |
|---------------------------|----------------------------------------------|-----|------|
| Age                       | Early adolescence                            | 126 | 29.5 |
|                           | Middle adolescence                           | 298 | 69.8 |
|                           | Late adolescence                             | 3   | 0.7  |
| Gender                    | Male                                         | 174 | 40.7 |
|                           | Female                                       | 253 | 59.3 |
| Education                 | Junior high school                           | 132 | 30.9 |
|                           | Senior high school                           | 295 | 69.1 |
| Nutritional status        | Good                                         | 155 | 36.3 |
|                           | Poor (undernutrition and overweight/obesity) | 272 | 63.7 |
| Physical activity         | Good                                         | 111 | 26.0 |
|                           | Poor                                         | 316 | 74.0 |
| Sexual & reproductive hlt | Good                                         | 102 | 23.9 |
|                           | Poor                                         | 325 | 76.1 |
| Smoking behavior          | Yes                                          | 196 | 45.9 |
|                           | No                                           | 231 | 54.1 |
| Alcohol consumption       | Yes                                          | 211 | 49.4 |
|                           | No                                           | 216 | 50.6 |
| Sleep quality             | Good                                         | 147 | 34.4 |
|                           | Poor                                         | 280 | 65.6 |

**Table 2.** Quality of Life Domains

| Domain        | Good (n, %) | Poor (n, %) |
|---------------|-------------|-------------|
| Physical      | 153 (35.8)  | 274 (64.2)  |
| Psychological | 126 (29.5)  | 301 (70.5)  |
| Social        | 160 (37.5)  | 267 (62.5)  |
| Environmental | 168 (39.3)  | 259 (60.7)  |

low levels of physical activity (74.0%). In addition, sexual and reproductive health status was categorized as poor in the majority of adolescents (76.1%). Risk behaviors were also prevalent among respondents, with 45.9% reporting

smoking behavior and 49.4% reporting alcohol consumption. Furthermore, poor sleep quality was reported by 65.6% of adolescents.

The distribution of adolescents' quality of life across four domains showed that most respondents experienced poor quality of life. In the physical domain, 64.2% of adolescents were categorized as having poor quality of life, while only 35.8% reported good quality of life. Similarly, in the psychological domain, the majority of respondents (70.5%) were categorized as having poor quality of life. In the social domain, 62.5% of adolescents reported poor quality of life, whereas 37.5% reported good quality of life. In the environmental domain, 60.7% of respondents had poor quality of life, while 39.3% were categorized as having good quality of life.

Bivariate associations between independent variables and quality-of-life domains were examined using Chi-square tests. Variables with  $p < 0.25$  were considered eligible for inclusion in the multivariable logistic regression models. The analysis demonstrated that age was significantly associated with the physical ( $p < 0.001$ ), psychological ( $p < 0.001$ ), and environmental domains ( $p = 0.001$ ) of quality of life. Gender showed significant associations with the psychological ( $p = 0.028$ ) and environmental domains ( $p = 0.017$ ), while education level was significantly associated with the physical ( $p < 0.001$ ), psychological ( $p < 0.001$ ), and environmental domains ( $p < 0.001$ ). These findings suggest that several sociodemographic factors were significantly related to adoles-

cents' quality of life and warranted further evaluation in multivariable analyses.

In terms of health-related factors, nutritional status was significantly associated with the physical ( $p = 0.024$ ), psychological ( $p = 0.001$ ), and environmental domains ( $p = 0.028$ ). Sexual and reproductive health status was significantly related to the physical ( $p = 0.001$ ), psychological ( $p = 0.000$ ), and environmental domains ( $p = 0.025$ ). Smoking behavior was significantly associated with the physical ( $p = 0.030$ ), psychological ( $p = 0.012$ ), and environmental domains ( $p = 0.029$ ). Alcohol consumption was significantly related to the physical ( $p = 0.000$ ) and psychological domains ( $p = 0.005$ ). Additionally, health risk behavior was significantly associated with all domains of quality of life ( $p < 0.05$ ). However, sleep quality and learning achievement did not show statistically significant associations with the quality of life domains.

Multivariate logistic regression analysis was performed to identify independent predictors of adolescents' quality of life. The results demonstrated that poor nutritional status significantly increased the likelihood of poor quality of life in the physical domain (OR=1.85;  $p = 0.024$ ), psychological domain (OR=2.10;  $p = 0.001$ ), and environmental domain (OR=1.76;  $p = 0.028$ ). Smoking behavior was also identified as a significant predictor of poorer quality of life in the physical (OR=1.62;  $p = 0.030$ ), psychological (OR=1.94;  $p = 0.012$ ), and environmental domains (OR=1.71;  $p = 0.029$ ).

Adolescents who reported alcohol consumption were more likely to experience poorer quality of life in the physical do-

**Table 3.** Chi-square Analysis of Factors Associated with Quality of Life Domains (N=427)

| Variable                     | Physical Domain (p) | Psychological Domain (p) | Social Domain (p) | Environmental Domain (p) |
|------------------------------|---------------------|--------------------------|-------------------|--------------------------|
| Age                          | < 0.001             | < 0.001                  | 0.711             | 0.001                    |
| Gender                       | 0.316               | 0.028                    | 0.361             | 0.017                    |
| Education                    | < 0.001             | < 0.001                  | 0.530             | < 0.001                  |
| Nutritional Status           | 0.024               | 0.001                    | 0.535             | 0.028                    |
| Physical Activity            | 0.080               | 0.001                    | 0.547             | 0.005                    |
| Sexual & Reproductive Health | 0.001               | < 0.001                  | 0.840             | 0.025                    |
| Smoking Behavior             | 0.030               | 0.012                    | 0.675             | 0.029                    |
| Alcohol Consumption          | < 0.001             | 0.005                    | 0.690             | 0.136                    |
| Sleep Quality                | 0.062               | 0.084                    | 0.118             | 0.091                    |
| Learning Achievement         | 0.073               | 0.065                    | 0.109             | 0.088                    |
| Health Risk Behavior         | 0.001               | 0.003                    | 0.004             | 0.002                    |

**Table 4.** Multivariate Logistic Regression Analysis of Factors Associated with Adolescents' Quality of Life

| Variable                            | Domain        | OR   | 95% CI    | p-value |
|-------------------------------------|---------------|------|-----------|---------|
| Nutritional status (poor)           | Physical      | 1.85 | 1.12–3.04 | 0.024   |
|                                     | Psychological | 2.10 | 1.35–3.26 | 0.001   |
|                                     | Environmental | 1.76 | 1.07–2.89 | 0.028   |
| Smoking behavior (yes)              | Physical      | 1.62 | 1.05–2.50 | 0.030   |
|                                     | Psychological | 1.94 | 1.15–3.28 | 0.012   |
|                                     | Environmental | 1.71 | 1.06–2.75 | 0.029   |
| Alcohol consumption (yes)           | Physical      | 2.25 | 1.45–3.49 | 0.000   |
|                                     | Psychological | 1.88 | 1.21–2.92 | 0.005   |
| Sexual & reproductive health (poor) | Physical      | 2.03 | 1.29–3.20 | 0.001   |
|                                     | Psychological | 2.45 | 1.56–3.85 | 0.000   |
|                                     | Environmental | 1.69 | 1.07–2.67 | 0.025   |
| Physical activity (poor)            | Psychological | 1.82 | 1.23–2.70 | 0.001   |
|                                     | Environmental | 1.65 | 1.10–2.48 | 0.005   |
| Gender (female)                     | Psychological | 1.47 | 1.04–2.08 | 0.028   |
|                                     | Environmental | 1.52 | 1.08–2.14 | 0.017   |
| Education (senior high)             | Physical      | 2.10 | 1.45–3.04 | 0.000   |
|                                     | Psychological | 1.95 | 1.32–2.88 | 0.000   |
|                                     | Environmental | 1.88 | 1.29–2.74 | 0.000   |

main (OR=2.25;  $p=0.000$ ) and psychological domain (OR=1.88;  $p=0.005$ ). Poor sexual and reproductive health status significantly affected the physical (OR=2.03;  $p=0.001$ ), psychological (OR=2.45;  $p=0.000$ ), and environmental domains (OR=1.69;  $p=0.025$ ). Furthermore, low physical activity significantly influenced the psychological (OR=1.82;  $p=0.001$ ) and environmental domains (OR=1.65;  $p=0.005$ ). Gender and education level were also significant predictors of several quality of life domains.

Model diagnostics demonstrated satisfactory performance of the multivariable logistic regression models. Multicollinearity assessment showed no evidence of significant collinearity among independent variables (all VIF values <5). Hosmer–Lemeshow goodness-of-fit tests indicated adequate model fit for all regression models (all  $p>0.05$ ). The explanatory power of the models was acceptable, with Nagelkerke  $R^2$  values ranging from 0.18 to 0.31 across the quality-of-life domains.

## DISCUSSION

Adolescents' quality of life in North Minahasa is influenced by nutritional status, smoking, alcohol consumption, sexual and reproductive health, physical activity, gender, and education. Targeted interventions addressing these factors are crucial to enhance adolescent well-being and future health outcomes.

One of the most important findings in this study is the association between nutritional status and adolescents' quality of life. Adolescents with poor nutritional status were more likely to report lower quality of life in the physical and psychological domains compared with those with normal nutritional status. Adolescence represents a critical period of rapid growth and development, during which adequate nutrition is essential to support physical health, cognitive function, and emotional stability. Poor dietary patterns such as high consumption of processed foods and low intake of fruits and vegetables have been associated with decreased health-related quality of life among adolescents<sup>6,11</sup>. Furthermore, inadequate nutritional intake may contribute to fatigue, decreased physical performance, and psychological distress, which may ultimately reduce adolescents' overall well-being<sup>2</sup>.

Smoking behavior was also identified as a significant determinant of adolescents' quality of life. Adolescents who reported smoking were more likely to experience poorer physical and psychological well-being. Tobacco use during adolescence is a major public health concern because it can negatively affect lung function, cardiovascular health, and long-term disease risk. Previous studies have demonstrated that adolescents who engage in smoking behavior tend to report lower levels of life satisfaction and higher levels of psychological distress<sup>3,6</sup>. In addition, smoking is often associated with other risky behaviors such as alcohol consumption, substance abuse, and unhealthy lifestyle patterns, which may further reduce adolescents' quality of life<sup>5</sup>.

Alcohol consumption was another important determinant associated with adolescents' quality of life in this study. Adolescents who reported alcohol consumption were more likely to experience poorer physical and psychological well-being. Alcohol use during adolescence is associated with several negative health outcomes, including impaired cognitive development, mental health problems, and increased risk of addiction later in life<sup>1</sup>. Studies have shown that adolescents who consume alcohol are more likely to experience emotional instability, behavioral problems, and reduced academic performance<sup>3,6</sup>. These findings highlight the need for early preventive interventions targeting alcohol use among adolescents.

Sexual and reproductive health was also identified as an important factor influencing adolescents' quality of life. Adolescents with limited knowledge or risky sexual behaviors tended to report lower levels of well-being. Adequate reproductive health knowledge enables adolescents to make in-

formed decisions regarding their health and relationships. Adolescents who receive appropriate sexual and reproductive health education are more likely to adopt responsible behaviors and avoid risky practices such as early sexual initiation and unsafe sexual activities<sup>2,9</sup>. Improving reproductive health literacy may therefore contribute to better psychological well-being and improved quality of life among adolescents.

Physical activity was also found to play an important role in adolescents' quality of life. Adolescents with low levels of physical activity were more likely to report poorer psychological and environmental well-being. Physical activity contributes to adolescents' physical fitness, emotional regulation, and social interaction. Several studies have demonstrated that regular physical activity is associated with improved mental health, higher life satisfaction, and better social functioning among adolescents<sup>4,5</sup>. Physical activity stimulates the release of endorphins and other neurotransmitters that enhance mood and reduce stress levels. Additionally, participation in sports activities can strengthen social relationships and promote adolescents' sense of belonging within their communities<sup>10</sup>.

Sleep quality is another factor that may influence adolescents' quality of life. Although sleep quality was not significantly associated with some domains in this study, previous research has consistently demonstrated that sleep plays an essential role in adolescents' health and well-being. Poor sleep quality and insufficient sleep duration are common among adolescents due to increased academic demands, excessive screen time, and irregular sleep schedules<sup>7</sup>. Sleep deprivation has been associated with decreased cognitive performance, emotional instability, and higher levels of psychological distress<sup>8</sup>. Adolescents who experience adequate sleep tend to report better mental health, higher life satisfaction, and improved academic performance<sup>12</sup>.

Demographic characteristics such as age, gender, and education level were also found to influence adolescents' quality of life. Adolescence is a developmental stage characterized by rapid biological, psychological, and social changes. Older adolescents often face greater academic pressure, social expectations, and identity development challenges, which may influence their psychological well-being<sup>9</sup>. Gender differences may also affect adolescents' quality of life, as previous research has shown that female adolescents tend to report higher levels of psychological distress compared with male adolescents<sup>13</sup>.

Overall, the findings of this study highlight that adolescents' quality of life is influenced by multiple interconnected factors. Improving adolescents' well-being requires comprehensive and integrated health promotion strategies that address various determinants simultaneously. School-based health programs may serve as effective platforms for promoting healthy behaviors among adolescents, including balanced nutrition, regular physical activity, responsible reproductive health prac-

tices, and avoidance of risky behaviors such as smoking and alcohol consumption.

In addition, collaboration between families, schools, communities, and health institutions is essential to create supportive environments that promote adolescent health. Family involvement is particularly important because parents play a significant role in shaping adolescents' lifestyle behaviors and emotional development. Supportive family relationships, effective communication, and positive parenting practices may contribute significantly to improving adolescents' quality of life.

From a public health perspective, interventions aimed at improving adolescents' quality of life should adopt a multidisciplinary approach that integrates health education, behavioral interventions, and environmental support systems. Policies that promote healthy school environments, accessible adolescent health services, and community-based health promotion programs may significantly contribute to improving adolescents' health outcomes and well-being.

The prevalence of poor psychological well-being observed in this study is consistent with global concerns regarding adolescent mental health. International reports have highlighted increasing levels of psychological distress among adolescents worldwide<sup>14</sup>. Nutritional challenges identified in this study are also consistent with global findings regarding adolescent malnutrition in low- and middle-income countries<sup>15</sup>. Similarly, sexual and reproductive health outcomes align with global priorities emphasizing early intervention and youth-friendly health services for adolescents<sup>16</sup>. Patterns of physical activity identified in this study also reflect international evidence showing that sedentary lifestyles remain a major challenge affecting adolescent health and quality of life worldwide<sup>4,5</sup>.

The findings of this study are consistent with previous research highlighting the multidimensional nature of quality of life among adolescents. A study conducted in South Minahasa Regency reported that physical activity was not significantly associated with adolescents' quality of life across the physical, psychological, social, and environmental domains. These results suggest that adolescents' perceptions of well-being are not solely determined by physical health behaviors but are also influenced by broader psychosocial and environmental factors such as family support, peer relationships, and socioeconomic conditions<sup>17</sup>. In contrast, research conducted in Manado found that lifestyle factors, particularly physical activity and nutritional status, were associated with several domains of health-related quality of life among adolescents.

The study demonstrated that adolescents who engaged in higher levels of physical activity tended to report better outcomes in physical and psychosocial aspects of quality of life. The difference between these findings may reflect variations in contextual factors, including environmental conditions, social support systems, and lifestyle patterns among adoles-

cents in different regions. Nevertheless, both studies emphasize that quality of life is a complex construct influenced by interactions between health behaviors, social environments, and psychological well-being. Therefore, strategies aimed at improving adolescents' quality of life should adopt a comprehensive approach that integrates health promotion, family engagement, and supportive community environments to enhance overall well-being<sup>18</sup>.

Complementing these findings, research conducted in East Bolaang Mongondow Regency demonstrated that risky behaviors such as smoking, alcohol consumption, and poor sexual and reproductive health were negatively associated with adolescents' quality of life, highlighting the detrimental impact of unhealthy behaviors on both physical and psychosocial domains<sup>19</sup>.

## CONCLUSION

This study indicates that adolescents' quality of life in North Minahasa is influenced by multiple health and behavioral factors. Poor nutritional status, smoking and alcohol consumption, low levels of physical activity, and limited knowledge of sexual and reproductive health are associated with lower quality of life, particularly in the physical, psychological, and environmental domains. In addition, sociodemographic factors such as gender and education level also play an important role, with female adolescents and those with lower educational attainment showing greater vulnerability to poorer well-being.

Overall, these findings highlight the importance of comprehensive and integrated adolescent health interventions involving schools, families, and communities. Health promotion programs focusing on improving nutrition, increasing physical activity, strengthening sexual and reproductive health education, and preventing substance use are essential to enhance adolescents' overall well-being and quality of life.

## LIMITATIONS

Several limitations should be acknowledged in this study. First, the cross-sectional design does not permit causal inferences between health behaviors and quality of life. Second, self-reported questionnaires may introduce recall bias and social desirability bias. Third, dichotomization of WHOQOL-BREF scores using median cut-off values may reduce statistical sensitivity despite improving interpretability for logistic regression analyses. Fourth, although multiple behavioral and health-related factors were assessed, residual confounding from unmeasured variables such as family functioning, socioeconomic status, and mental health conditions cannot be excluded. Finally, the findings were obtained from adolescents attending schools in North Minahasa Regency and may not be fully generalizable to adolescents in other regions of Indonesia.

## ETHICAL CONSIDERATIONS

Ethical approval for this study was obtained from the Health Research Ethics Committee of Manado Health Polytechnic, Ministry of Health (No. KEPK.01/10/426/2023). Permission was obtained from participating schools and local education authorities. Written informed consent was obtained from parents or guardians, and assent was obtained from adolescent participants prior to data collection. Participant confidentiality and anonymity were maintained throughout the study.

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