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Factors Influencing Healthy Lifestyle Adoption to Prevent Diabetes in Adolescents

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ABSTRACT
Type 2 Diabetes Mellitus (DMT2) prevalence is rising among adolescents globally. Unhealthy lifestyle behaviors including low physical activity, poor dietary patterns, negative attitudes, and inadequate family support are primary risk factors for early-onset DMT2. This study examines the relationships between these modifiable lifestyle factors and healthy lifestyle implementation among adolescents in Bandar Lampung, Indonesia. A quantitative cross-sectional study was conducted at Puskesmas Sumur Batu and Labuhan Ratu, Bandar Lampung City (2026). A total of 363 adolescents aged 12–14 years were selected using proportional random sampling (Slovin formula, 10% margin of error). Structured and validated questionnaires (Pearson r>0.361; Cronbach's alpha>0.70) measured physical activity, dietary pattern, attitude, and family support. Data were analyzed using univariate, bivariate (Chi-square), and multivariate (logistic regression) analyses. Statistically significant associations were found for all four independent variables with healthy lifestyle implementation: physical activity (OR=1.801, 95% CI: 1.083–2.997; p=0.031), dietary pattern (OR=2.333, 95% CI: 1.417–3.842; p=0.001), attitude (OR=1.927, 95% CI: 1.168–3.178; p=0.014), and family support (OR=1.739, 95% CI: 1.061–2.851; p=0.037). Multivariate logistic regression identified dietary pattern as the strongest determinant (adjusted OR=2.179; 95% CI: 1.338–3.547; p=0.002). Dietary pattern is the dominant factor influencing healthy lifestyle implementation among adolescents. All four lifestyle factors were independently and significantly associated with healthy lifestyle behavior. Evidence-based health promotion strategies, particularly nutrition education and multidisciplinary interventions targeting adolescents and their families, are essential for DMT2 prevention. Study limitations include self-reported data and two-site sampling, which may limit generalizability.

INTRODUCTION

The rapid modernization of lifestyle has fundamentally shifted dietary habits among populations globally, with convenience-oriented food choices high in fat, sugar, and salt becoming increasingly prevalent. Type 2 Diabetes Mellitus (DMT2), historically termed an adult-onset disease, has emerged as a significant and growing health threat among adolescent populations worldwide. The International Diabetes Federation (IDF, 2024) estimated that 589 million adults aged 20–79 years were living with diabetes, representing an 11.1% global prevalence, with 42.8% remaining undiagnosed.[1] Globally, diabetes mellitus ranks as the 7th leading cause of mortality, with 90–95% of cases classified as

DMT2. Indonesia ranks 6th globally, with approximately 10.2 million cases documented in 2017 and projections of 16.7 million by 2045.[1]

The Indonesian Basic Health Research (SKI, 2023) reported a significant increase in diabetes prevalence among individuals aged ≥15 years, rising from 10.9% in 2018 to 11.7% in 2023.[2] This epidemiological transition reflects a substantial lifestyle-related disease burden. In Lampung Province, diabetes prevalence stands at 0.8%, with Bandar Lampung City ranking 5th at 0.9% (Ministry of Health, 2018). The Bandar Lampung City Health Office Standard Minimum Service (SPM) report (2023) documented 19,100 diabetes patients citywide. At the primary healthcare level, Puskesmas Sumur Batu recorded 495 diabetes patients (148 aged ≥10 years), and Puskesmas Labuhan Ratu documented 936 patients (280 aged ≥10 years) in 2024. Critically, 72% of adolescents in Bandar Lampung spend >4 hours daily on sedentary activities, while 68% consume fast food ≥3 times weekly, risk patterns that contextualize this study's focus on these two Puskesmas.[3]

DMT2 is characterized by insulin resistance coupled with impaired insulin secretion, resulting in elevated blood glucose levels with serious health consequences. Adolescence represents a critical developmental period, with contemporary adolescents demonstrating heightened DMT2 vulnerability due to lifestyle choices including high-fat and high-sugar food consumption, physical inactivity, and smoking. Research demonstrates that fast food consumption exceeding twice weekly doubles prediabetes risk among adolescents, while inadequate physical activity compounds this risk by reducing insulin sensitivity.[4]

Two theoretical frameworks underpin the present study. The Health Belief Model (HBM) offers an effective lens for understanding adolescent health behavior by incorporating perceived susceptibility, severity, benefits, and barriers to action—critical dimensions for diabetes prevention education.[5] The Theory of Planned Behavior (TPB) further elucidates how behavioral intentions are shaped by attitudes, social norms, perceived behavioral control, and self-efficacy.[6] Together, these frameworks inform how physical activity, dietary patterns, attitudes, and family support interact to influence adolescent health behaviors.

Psychosocial factors also significantly influence DMT2 risk. Kakleas et al. (2019) demonstrated that adolescents with diabetes face elevated psychological distress, leading to treatment non-compliance and reduced glycemic control. Studies by Saputra et al. (2025) established that knowledge, attitude, and family support are significantly associated with blood glucose control, with poor knowledge increasing risk of poor glycemic control by 22-fold.[7] Despite established prevention strategies, including education, physical activity, nutritional management, and routine monitoring, adolescent diabetes awareness remains inadequate in many communities.

Given this evidence base, this study aims to examine the relationships between physical activity, dietary patterns, attitudes, and family support with the implementation of a healthy lifestyle among adolescents in the Bandar Lampung City Health Office area, and to identify the most dominant determinant factor for targeted health promotion interventions.

MATERIALS AND METHODS

Study Design and Setting

This quantitative cross-sectional study examined associations between modifiable lifestyle factors and healthy lifestyle implementation among adolescents. The study was conducted at two purposively selected Community Health Centers (Puskesmas) in Bandar Lampung City: Puskesmas Sumur Batu (coastal area, highest adolescent population among coastal sites) and Puskesmas Labuhan Ratu (border with South Lampung Regency, highest adolescent diabetes burden). Purposive site selection is acknowledged as a potential limitation affecting generalizability beyond these catchment areas.

Population, Sample, and Sampling

The target population comprised 99,847 adolescents aged 12–14 years across 31 Puskesmas in Bandar Lampung City. Sample size was calculated using Slovin's formula with a 10% margin of error, corresponding to a 90% confidence level—a threshold appropriate for cross-sectional community health studies—yielding 363 respondents. Proportional random sampling distributed participants across study sites: 132 from Sumur Batu and 231 from Labuhan Ratu. Inclusion criteria were: age 12–14 years, native residency in Bandar Lampung, and signed informed consent. Exclusion criteria included: age >15 years, incomplete questionnaires (>10% missing responses), and presence of chronic conditions (hypertension, cancer, type 1 diabetes mellitus). No significant missing data were encountered after exclusion.

Instruments and Data Collection

Primary data collection used three validated instruments: the Physical Activity Level (PAL) form, the Food Frequency Questionnaire (FFQ), and Likert-scale questionnaires for attitude and family support. Instrument validity was assessed via Pearson product-moment correlation on a 30-respondent pilot sample in Metro City (all items: $r > 0.361$ at $\alpha=0.05$). Reliability was confirmed by Cronbach's alpha >0.70 for all variables, meeting accepted internal consistency thresholds. Secondary data (demographic profiles and diabetes prevalence) were obtained from Puskesmas reports. Variables were coded as binary: physical activity (1=Good, 0=Not Good), dietary pattern (1=Good, 0=Not Good), attitude (1=Positive, 0=Negative), family support (1=Supportive, 0=Not Supportive), and healthy lifestyle implementation (1=Implemented, 0=Not Implemented).

Statistical Analysis

Univariate analysis described frequency distributions and percentages. Bivariate analysis used the Chi-square test (significance threshold: $p<0.05$); expected cell frequencies were verified ≥5 in all analyses. Multivariate logistic regression included all variables meeting $p\leq0.25$ in bivariate analysis. Multicollinearity was assessed using variance inflation factors (VIF<2.5 for all predictors). Model fit was evaluated using the Hosmer-Lemeshow test ($p=0.421$, indicating good fit) and Nagelkerke R^2. Odds ratios (OR) with 95% confidence intervals (CI) were reported throughout.

Ethical Considerations

Ethical clearance was obtained from the relevant institutional review board prior to data collection. All participants provided voluntary signed informed consent; minors' consent was accompanied by parental/guardian assent. Participants were assigned coded identifiers to ensure anonymity, and all data were maintained in strict confidentiality. Participants could withdraw at any time without penalty.

RESULTS

Univariate Analysis

Table 1 presents the frequency distribution of all study variables (n=363). A majority of respondents demonstrated favorable conditions across all predictors: good physical activity (78.0%, n=283), good dietary patterns (75.2%, n=273), positive attitudes toward healthy behavior (76.6%, n=278), and supportive family environments (76.3%, n=277). These findings indicate that most adolescents possessed the prerequisite attitudinal and environmental conditions for healthy lifestyle adoption. However, fewer than half of all respondents (48.8%, n=177) actually implemented a healthy lifestyle, revealing a substantial gap between favorable preconditions and actual behavioral outcomes. This implementation gap is particularly notable for dietary pattern: while 75.2% reported good dietary habits, only 53.8% of those with good dietary patterns translated this into full healthy lifestyle implementation, suggesting that dietary behavior alone is necessary but not sufficient—supporting the need for a multi-factor approach

Bivariate Analysis: Associations with Healthy Lifestyle Implementation

Table 1 presents the consolidated Chi-square results for all independent variables. All four lifestyle factors were statistically significantly associated with healthy lifestyle implementation ($p<0.05$). Among respondents with good physical activity, 51.9% implemented healthy lifestyles, versus only 37.5% among those with poor physical activity (OR=1.801; 95% CI: 1.083–2.997; $p=0.031$), indicating that good physical activity confers an 80.1% increased likelihood of healthy

lifestyle adoption. Dietary pattern demonstrated the strongest bivariate association: 53.8% of those with good dietary habits implemented healthy lifestyles versus 33.7% of those with poor dietary habits (OR=2.333; 95% CI: 1.417–3.842; p=0.001), a 133% increased likelihood. Positive attitude was associated with a 92.7% increased likelihood of healthy lifestyle implementation (52.5% vs. 36.5%; OR=1.927; 95% CI: 1.168–3.178; p=0.014). Supportive family environments conferred a 73.9% increased likelihood compared to unsupportive environments (52.0% vs. 38.4%; OR=1.739; 95% CI: 1.061–2.851; p=0.037). Chi-square assumptions (expected cell frequency ≥5) were confirmed for all analyses.

Table 1. Bivariate Analysis – Relationships Between Lifestyle Factors and Healthy Lifestyle Implementation (n=363)

Variable	Healthy Lifestyle Implementation				Total		OR (95% CI)	p-value
	Implemented n	%	Not Implemented n	%	n	%		
Physical Activity								
Good	147	51.9	136	48.1	283	78.0	**1.801 (1.083–2.997)**	0.031
Not Good	30	37.5	50	62.5	80	22.0		
Total	177	48.8	186	51.2	363	100.0		
Dietary Pattern								
Good	147	53.8	126	46.2	273	75.2	**2.333 (1.417–3.842)**	0.001
Not Good	30	33.7	60	66.7	90	24.8		
Total	177	48.8	186	51.2	363	100.0		
Attitude								
Positive	146	52.5	132	47.5	278	76.6	**1.927 (1.168–3.178)**	0.014
Negative	31	36.5	54	63.5	85	23.4		
Total	177	48.8	186	51.2	363	100.0		
Family Support								
Supportive	144	52.0	133	48.0	277	76.3	**1.739 (1.061–2.851)**	0.037
Not Supportive	33	38.4	53	61.6	86	23.7		
Total	177	48.8	186	51.2	363	100.0		

Figure 1 provides a comparative visual summary of healthy lifestyle implementation rates across favorable and unfavorable categories for each variable, highlighting the consistent pattern whereby respondents with positive lifestyle attributes are substantially more likely to implement healthy behaviors.

Multivariate Analysis: Logistic Regression

All four variables met the inclusion criterion (bivariate p≤0.25) for multivariate modeling. The Hosmer-Lemeshow goodness-of-fit test confirmed acceptable model fit (p=0.421). Nagelkerke R^2=0.187, indicating that the four-variable model explains approximately 18.7% of variance in healthy lifestyle implementation a result consistent with cross-sectional lifestyle studies acknowledging additional unmeasured influences. VIF values for all predictors were <2.5, confirming absence of problematic multicollinearity. Table 3 presents the final logistic regression model with adjusted ORs and 95% CIs.

Table 3. Multivariate Logistic Regression – Final Model: Determinants of Healthy Lifestyle Implementation (n=363)

No.	Variable	B	p-value	Adjusted OR	95% CI
1	Physical Activity	0.527	0.049	1.694	1.023–2.804
2	Dietary Pattern	0.779	0.002	2.179	1.338–3.547
3	Attitude	0.669	0.038	1.953	1.186–3.218
4	Family Support	0.547	0.026	1.728	1.068–2.797

Hosmer-Lemeshow test: p=0.421; Nagelkerke R^2=0.187; All VIF <2.5

After controlling simultaneously for all four lifestyle factors, dietary pattern remained the most dominant determinant of healthy lifestyle implementation (adjusted OR=2.179; 95% CI: 1.338–3.547; p=0.002). This means that adolescents with good dietary patterns were 2.18 times more likely to implement a healthy lifestyle compared to those with poor dietary patterns, independent of their physical activity, attitude, and family support. Attitude ranked second (adjusted OR=1.953), followed by family support (adjusted OR=1.728) and physical activity (adjusted OR=1.694). The consistency between bivariate and multivariate rankings—with dietary pattern dominant in both analyses—strengthens the reliability of this finding.

DISCUSSION

Physical Activity and Healthy Lifestyle Implementation

The significant association between physical activity and healthy lifestyle implementation (OR=1.801; 95% CI: 1.083–2.997; p=0.031) in this study adds to a growing body of evidence linking physical activity to metabolic health outcomes in adolescents. Specifically, the OR of 1.801 indicates that adolescents with adequate physical activity are 80.1% more likely to implement comprehensive healthy lifestyles a finding that differs from prior studies focused solely on glycemic outcomes. Larasati (2013) found that regular physical activity significantly reduced HbA1c levels (p=0.001) through enhanced insulin receptor sensitivity and skeletal muscle glucose utilization, mechanisms that align with our finding.[9] Nuryati (2017) similarly demonstrated significant correlations between physical activity and random blood glucose levels (p=0.000).[10]

A critical finding of this study is the implementation gap between physical activity and overall healthy lifestyle adoption. Although 78.0% of respondents reported good physical activity, only 48.8% demonstrated a comprehensive healthy lifestyle. This suggests that physical activity alone is insufficient to promote holistic behavioral change without simultaneous improvements in dietary habits, health attitudes, and family support. Therefore, adolescent health promotion programs should adopt integrated interventions combining physical activity promotion, nutrition education, and family-based support rather than focusing solely on exercise.

Dietary Pattern and Healthy Lifestyle Implementation

Dietary pattern emerged as the most influential factor associated with healthy lifestyle implementation, demonstrating the strongest relationship in both bivariate (OR=2.333; 95% CI: 1.417–3.842; p=0.001) and multivariate analyses (adjusted OR=2.179; 95% CI: 1.338–3.547; p=0.002). Participants with good dietary patterns showed a 20.1 percentage point higher prevalence of healthy lifestyle implementation compared with those with poor dietary patterns (53.8% vs. 33.7%), representing the largest disparity among all examined variables. This finding corroborates previous studies identifying dietary behavior as a major determinant of metabolic risk and a central factor in adolescent DMT2 prevention. Our results extend this evidence by confirming the strength of this association within the Bandar Lampung adolescent population and by demonstrating that dietary pattern exerts a greater relative influence than physical activity, attitude, and family support.

The persistence of dietary pattern as the strongest predictor after multivariate adjustment suggests that its contribution to DMT2 prevention operates through mechanisms not fully explained by other lifestyle-related factors. Given the high proportion of adolescents with poor dietary habits characterized by frequent consumption of fast foods, sugar-sweetened beverages, and processed snacks, dietary intervention should be prioritized in prevention strategies. Accordingly, school-based nutritional policies, including healthier canteen regulations and structured nutrition education

integrated into the school curriculum, may represent the most strategic intervention to reduce future DMT2 risk among adolescents.

Attitude and Healthy Lifestyle Implementation

The significant association between attitude and healthy lifestyle implementation (OR=1.927; 95% CI: 1.168–3.178; p=0.014) confirms that adolescent health beliefs are a meaningful determinant of behavioral outcomes, though they explain less variance than dietary patterns in multivariate analysis (adjusted OR=1.953 vs. 2.179). The 16-percentage-point gap in implementation rates between positive (52.5%) and negative (36.5%) attitude groups indicates that attitudinal barriers are a meaningful target for intervention. This finding aligns with Rachmawati et al. (2022) (p=0.003) and Hardianto (2020) (p=0.004), and extends their work by demonstrating that attitude is independently associated with lifestyle implementation after controlling for dietary pattern, physical activity, and family support.

A key limitation here is that our study used cross-sectional data, making it impossible to determine whether positive attitudes preceded lifestyle implementation or whether experiencing healthy outcomes reinforced positive attitudes. This is a recognized challenge in health behavior research. Practically, the TPB framework suggests that health education programs must target all three components of behavioral intention: attitudes (through personalized risk communication highlighting DMT2 susceptibility), subjective norms (through peer-led healthy lifestyle champions), and perceived behavioral control (through practical skill-building sessions on healthy food preparation and self-monitoring). Social media campaigns tailored to adolescent platforms particularly short-form video content demonstrating accessible healthy behaviors may be particularly effective given this age group's high digital media engagement.

Family Support and Healthy Lifestyle Implementation

Family support was significantly associated with healthy lifestyle implementation (OR=1.739; 95% CI: 1.061–2.851; p=0.037), with supportive families demonstrating a 13.6 percentage point higher implementation rate than non-supportive families (52.0% vs. 38.4%). This finding confirms family support as an important environmental determinant of adolescent health behavior and aligns with previous studies highlighting the influence of familial emotional and informational support on healthy lifestyle practices. Notably, family support remained an independent predictor after controlling for attitude, dietary pattern, and physical activity, indicating that its influence extends beyond individual behavioral factors. Although its adjusted effect size was lower than dietary pattern and attitude, family support remains a relevant target for intervention. Parent-inclusive health promotion strategies through Puskesmas and family-based diabetes prevention education may

strengthen adolescent adherence to healthy lifestyle behaviors and enhance the effectiveness of individual-level prevention programs..

Multivariate Findings: Integrated Interpretation and Policy Implications

The multivariate logistic regression confirms that all four lifestyle factors contribute independently and significantly to healthy lifestyle implementation, collectively explaining 18.7% of variance (Nagelkerke R^2=0.187). The remaining 81.3% is attributable to unmeasured factors including socioeconomic status, school environment quality, genetic predisposition, peer influence networks, and access to healthy foods—variables that should be incorporated in future research. The consistent ranking of dietary pattern as the dominant factor across both bivariate and multivariate analyses strengthens the inference that nutritional behavior is the pivotal intervention target.

For regional health policy, the Bandar Lampung City Health Office should prioritize integrating dietary counseling into the Remaja (adolescent) health screening program (Pelayanan Kesehatan Remaja) at all Puskesmas, with dietary pattern assessment as a standard component. At the national level, the Ministry of Health's Gerakan Masyarakat Hidup Sehat (GERMAS) initiative should strengthen its adolescent-specific components to address fast food consumption norms and physical activity barriers identified in this study.

CONCLUSION

This study demonstrates that physical activity, dietary pattern, attitude, and family support are each significantly and independently associated with the implementation of a healthy lifestyle among adolescents in the Bandar Lampung City Health Office area. Dietary pattern emerged as the most dominant determinant in multivariate analysis (adjusted OR=2.179; 95% CI: 1.338–3.547; p=0.002), indicating that adolescents with good dietary habits are approximately 2.2 times more likely to adopt comprehensive healthy lifestyle behaviors, after controlling for the other lifestyle factors.

These findings highlight the urgency of developing evidence-based, multi-component health promotion programs for adolescent DMT2 prevention that prioritize nutrition education while also addressing physical activity promotion, attitudinal change, and family engagement. Future research should incorporate broader sampling across multiple districts to enhance generalizability, include additional potential confounders such as socioeconomic status and school environment, and consider longitudinal designs to establish causal pathways. Healthcare policymakers should integrate these findings into school-based and community-based adolescent health promotion strategies in Bandar Lampung and similar settings.

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