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Who keeps smoking? A repeated cross-sectional analysis of adolescent behaviour in Indonesia

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Abstract: Adolescent smoking remains a significant public health issue, particularly in low- and middle-income countries such as Indonesia. This study examined how socio-demographic, economic, environmental, and psychological factors influence smoking initiation and persistence among adolescents. A repeated cross-sectional analysis was conducted using data from the Indonesian Family Life Survey (IFLS) waves 3 (2000), 4 (2007), and 5 (2014), focusing on adolescents aged 15–19 years. Smoking initiation was defined as having ever smoked, and persistence as continued smoking after initiation. Logistic regression was used to assess associations with age, gender, education, academic performance, parental smoking, income, school characteristics, area of residence, and depressive symptoms. Results showed that while overall initiation declined, older adolescents (17–19 years), males, and those from low-income households remained at higher risk. Being employed increased the odds of initiation, while higher education was protective. Persistence was more likely among males, unemployed adolescents, and those with smoking parents. Depression was associated with increased initiation but lower persistence, suggesting experimentation rather than long-term use. These findings highlight the roles of socioeconomic and mental health factors in shaping smoking behavior. Targeted tobacco control interventions and integrated mental health support are urgently needed, particularly for male adolescents and those exposed to parental smoking.

Keywords: *Adolescent smoking, Indonesia, Smoking initiation, Smoking persistence, Tobacco control.*

1. Introduction

Smoking is a major risk factor for non-communicable diseases (NCDs) and remains a global public health concern. Smoking increases the risk of developing chronic conditions such as bronchitis, lung cancer, coronary heart disease, and stroke, all of which have been increasing in prevalence worldwide [1, 2]. According to the latest estimates, tobacco use was responsible for 8.7 million deaths globally [3]. In 2022, there were approximately 1.25 billion smokers worldwide [4] with over 80% of them having started smoking between the ages of 14 and 25 years, and 18.5% becoming regular smokers by the age of 15 [5]. The rising number of adolescent smokers across various countries underscores the importance of understanding the factors contributing to smoking initiation and persistence [6, 7]. Studies indicate that one in five high school students has experimented with smoking, and one in eleven becomes a habitual smoker [8-10]. In Asia, adolescents typically initiate smoking between the ages of 10 and 14 [11] whereas in Africa, smoking initiation has been reported as early as 7 years old or younger [12].

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Adolescence is a critical period of neurocognitive and hormonal development [13] during which individuals are shaped by personality traits, behavioral tendencies, and socio-environmental influences [14]. During this stage, adolescents are particularly vulnerable to nicotine addiction and smoking initiation [15] increasing the likelihood of transitioning to regular smoking [16, 17]. Without effective interventions to prevent early smoking initiation, tobacco use is likely to persist across generations [18]. Despite global efforts to curb adolescent smoking through tobacco control measures, the continued high prevalence of youth smoking in many countries highlights the urgent need for enhanced intervention strategies [19]. To develop effective adolescent tobacco control programs, a comprehensive understanding of the determinants of smoking initiation and persistence is essential [20].

Although various global tobacco control policies, including the WHO Framework Convention on Tobacco Control (FCTC), have been implemented to reduce smoking initiation among young people, the effectiveness of these measures varies across different populations [21]. Strategies such as higher tobacco taxation), advertising bans , and school-based interventions have had mixed success, particularly in low- and middle-income countries (LMICs) [22-24] where cigarettes remain affordable, and tobacco marketing remains pervasive. Indonesia, in particular, has one of the highest smoking prevalence rates among adolescents in Southeast Asia. Despite existing regulations, such as pictorial health warnings and partial advertising bans, aggressive tobacco industry marketing and the availability of low-cost cigarettes continue to contribute to high smoking initiation rates among young people [25].

A growing body of literature has identified multiple factors influencing adolescent smoking behaviors, which can be grouped into several determinant categories. Sociodemographic factors such as age, sex, education level, and school performance play a significant role, with studies showing that male adolescents and those with lower academic achievement are more likely to initiate smoking [12, 26, 27]. Socioeconomic determinants, including parental occupation, parental education, parental smoking status, household income, and individual purchasing power, have also been linked to smoking initiation and persistence. Adolescents from families with smokers or low-income backgrounds are often at higher risk [28, 29].

Environmental influences further contribute to smoking behavior. Place of residence (urban or rural), school type (public or private), and school location may shape accessibility to cigarettes and exposure to tobacco marketing [30, 31]. For instance, schools in urban settings or near retail cigarette outlets may increase students' risk of smoking [32]. In addition, psychological factors particularly symptoms of depression, anxiety, or emotional distress have been shown to correlate strongly with both smoking initiation and continued use [33] 6 Adolescents with poor mental health may use tobacco as a coping mechanism [34, 35].

Analyzing the determinants of smoking initiation and persistence among adolescents is crucial, as adolescence is a formative period in which lifelong behaviors are often established [36]. Initiating smoking at a young age is associated with a higher risk of long-term nicotine dependence and the development of non-communicable diseases [37] which pose a significant burden to national health systems. Identifying the underlying factors that lead adolescents to start and continue smoking is essential for developing targeted and effective prevention strategies.

In the Indonesian context, exposure to cigarette advertising, weak regulatory enforcement, and peer or family influence are key contributors to youth smoking behavior [38]. A long-term analysis of adolescent smoking patterns provides an opportunity to assess how social dynamics and public health policies have evolved over time. The findings of this study are expected to inform evidence-based interventions and support policymakers in designing youth-centered tobacco control initiatives.

2. Methods

This study employs a repeated cross-sectional design using secondary data from the Indonesian Family Life Surveys (IFLS) across three waves: IFLS 3 (2000), IFLS 4 (2007), and IFLS 5 (2014). The

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IFLS is a nationally representative survey that collects comprehensive health, socioeconomic, and demographic information from individuals and households in Indonesia.

2.1. Study Population and Data Collection

This study utilized data from 13 out of Indonesia's 27 provinces, selected through a stratified random sampling design to ensure representativeness, including North Sumatra, West Sumatra, South Sumatra, Lampung, DKI Jakarta, Central Java, DI Yogyakarta, East Java, West Java, Bali, West Nusa Tenggara, South Kalimantan, and South Sulawesi [39]. These provinces were selected to represent approximately 83% of the Indonesian population from the initiation of IFLS in 1993, capturing regional diversity in smoking behaviors and associated determinants.

The study population consists of adolescents aged 15–19 years at the time of each survey wave. Smoking behavior was assessed through self-reported responses regarding smoking initiation and persistence.

2.2. Definition of Smoking Initiation and Persistence

Smoking initiation was identified based on responses to the survey question: "Have you ever had a habit of chewing tobacco, smoking tobacco with a pipe, smoking self-rolled tobacco, or smoking cigarettes/cigars?". Adolescents who answered "yes" were classified as having initiated smoking. Smoking persistence was determined using the survey question "Is your smoking habit still ongoing?'. Respondents who reported continued smoking were classified as persistent smokers.

2.3. Determinants of Smoking Behavior

Several factors were analyzed as potential determinants of smoking initiation and persistence, categorized as follows:

1. Sociodemographic Determinants: age, sex, education level, and school performance.
2. Socioeconomic Determinants: parental occupation, parental education, parental smoking status, parental income, personal income, cigarette price, cigarette type, and cigarette brand.
3. Environmental Determinants: place of residence (urban/rural), school management type (public/private), and school location.
4. Psychological Determinants: depression, assessed using standardized mental health indicators in the IFLS dataset.

2.4. Statistical Analysis

Descriptive analyses were conducted to examine trends in smoking initiation and persistence across survey waves. Bivariate analyses were performed to assess associations between smoking behavior and each determinant. Multivariable logistic regression models were then used to identify factors associated with smoking initiation and persistence. The models were adjusted for potential confounders, and results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

2.5. Ethical Considerations

Ethical approval for this study was obtained from the Medical and Health Research Ethics Committee, Faculty of Medicine, Universitas Sebelas Maret, with approval number: 01/02/01/2022/04. In addition, permission to use the IFLS 3–5 data was granted by RAND Corporation, the organization responsible for conducting the IFLS surveys.

3. Results

9,399 adolescents aged 15–19 years were included in the analysis across three survey waves (2000, 2007, and 2014). The proportion of male respondents was 49.01%, and most were enrolled in public school. The prevalence of smoking initiation was 20.94% in 2000, 18.48% in 2007, and 18.97% in 2014, while smoking persistence rates were 96.84%, 97.45%, and 91.62%, respectively.

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Figure 1 presents the trends in adolescent smoking behavior across the three survey waves. The prevalence of smoking initiation showed a trend, with the highest rates observed in wave 4 (2007), while smoking persistence was highest in wave 3 (2000). A slight decline in smoking initiation was observed in wave 5 (2014), suggesting potential effects of tobacco control measures implemented during this period. However, despite this decline, smoking persistence remained relatively stable, indicating challenges in cessation efforts among adolescents.

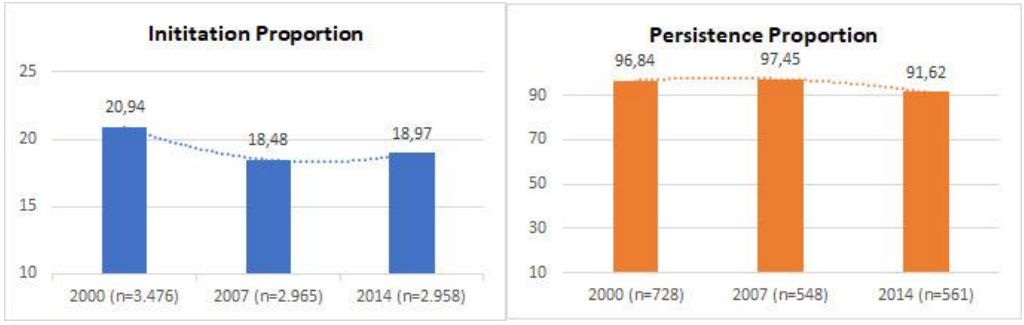

Figure 1.
The trends in adolescent smoking behavior across the three survey waves.

Table 1 presents the distribution of adolescent smoking initiation and persistence across different survey waves (2000, 2007, and 2014) based on key demographic, socioeconomic, environmental, and psychological determinants.

For smoking initiation, the proportion of new smokers varied across waves, with a general decline over time. A higher prevalence of initiation was observed among late adolescents, males, those with elementary-junior high school education, those unemployed, and those with good academic performance. Socioeconomic factors such as parental education and income also showed variations, with higher initiation rates among adolescents from lower-middle-income households. Additionally, adolescents residing in urban areas and attending public schools were more likely to start smoking compared to their rural and private school counterparts.

For smoking persistence, males had significantly higher persistence rates compared to females. Unemployed adolescents who were unemployed, had smoking parents, or had not experienced depressive symptoms also demonstrated a higher likelihood of continuing smoking.

Table 2 summarizes the association between determinants and smoking behavior. The sociodemographic factors influencing smoking behavior among adolescents reveal significant trends across various aspects. Age plays a crucial role, as late adolescents (aged 17–19) demonstrated a significantly higher likelihood of initiating smoking compared to their younger counterparts in early adolescence (OR: 3.211, 95% CI: 2.344 - 4.398). Gender differences were also evident, with males consistently being more likely to start smoking across all survey waves. Moreover, male adolescents exhibited a higher rate of smoking persistence in the fourth wave compared to females (OR: 0.006, 95% CI:0.003 - 0.012).

Education and school performance also emerged as critical determinants. Adolescents with lower academic achievement were found to have a greater likelihood of initiating smoking, particularly in the fifth survey wave (OR: 1.478, 95% CI:1.074 - 2.034). Additionally, employment status appeared to influence smoking behavior, as adolescents who were employed showed a consistently higher likelihood of initiating smoking compared to their unemployed peers (OR: 2.417, 95% CI: 1.510 - 3.870).

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Table 1.
Characteristics of the selected respondents according to IFLS wave.

Characteristic	Initiation				Persistence			
	Wave 3 (n=3,476)	Wave 4 (n=2,965)	Wave 5 (n=2,958)	All waves (n=9.399)	Wave 3 (n=728)	Wave 4 (n=548)	Wave 5 (n=561)	All waves (n=1,837)
Sociodemographic								
Age								
Early Adolescents	178 (24,5)	121 (22,0)	179 (31,9)	478 (26,0)	169 (22,97)	117 (21,91)	152 (29,57)	438 (24,99)
Late Adolescents	550 (75,5)	427 (77,9)	382 (68,0)	1,359 (73,9)	536 (76,03)	417 (78,09)	362 (70,43)	1,315 (75,01)
Gender								
Female	7 (0,96)	2 (0,36)	8 (1,43)	17 (0,93)	4 (0,57)	0 (0,00)	3 (0,58)	7 (0,40)
Male	721 (99,0)	546 (99,64)	553 (98,57)	1,820 (99,07)	701 (99,43)	534 (100,0)	511 (99,42)	1,746 (99,60)
Adolescent Education								
Not in School / Yet to Attend School	165 (22,6)	132 (24,09)	97 (17,29)	394 (21,45)	164 23,26)	130 (24,34)	91 (17,70)	385 (21,96)
Elementary - Junior High School	352 (48,3)	237 (43,25)	223 (39,75)	812 (44,20)	343 (48,65)	232 (43,45)	201 (39,11)	776 (44,27)
Senior High School	203 (27,8)	165 (30,11)	227 (40,46)	595 (32,39)	192 (27,23)	159 (29,78)	209 (40,66)	560 (31,95)
Diploma - Bachelor's Degree	8 (1,10)	14 (2,55)	14 (2,50)	36 (1,96)	60 (0,85)	13 (2,43)	13 (2,53)	32 (1,83)
School Performance								
Elementary School								
Good (≥ average)	531 (72,94)	496 (90,51)	212 (37,79)	1,239 (67,45)	513 (72,77)	482 (90,26)	199 (38,72)	1,194 (68,11)
Poor (< average)	197 (27,06)	52 (9,49)	349 (62,21)	598 (32,55)	192 (27,23)	52 (9,74)	315 (61,28)	559 (31,89)
Junior High School								
Good (≥ average)	543 (74,59)	347 (63,32)	401 (71,48)	1,291 (70,28)	524 (74,33)	340 (63,67)	369 (71,79)	1233 (70,34)
Poor (< average)	185 (24,41)	201 (36,68)	160 (28,52)	546 (29,72)	181 (25,67)	194 (36,33)	145 (28,21)	520 (29,66)
Senior High School								
Good (≥ average)	365 (50,14)	337 (61,50)	285 (50,80)	987 (53,73)	353 (50,07)	330 (61,80)	262 (50,97)	945 (53,91)
Poor (< average)	363 (49,86)	211 (38,50)	276 (49,20)	850 (46,27)	352 (49,93)	204 (38,20)	252 (49,03)	808 (46,09)
Employment Status								
Unemployed	357 (49,04)	275 (50,18)	316 (56,33)	948 (51,61)	338 (47,94)	266 (49,81)	280 (54,47)	884 (50,43)
Employed	371 (50,96)	273 (49,82)	245 (43,67)	889 (48,39)	367 (52,06)	268 (50,19)	234 (45,53)	869 (49,57)
Socioeconomic								
Household Head's Employment Status								
Unemployed	86 (11,81)	73 (13,32)	81 (14,44)	240 (13,06)	80 (11,35)	73 (13,67)	76 (14,79)	229 (13,06)
Employed	642 (88,19	475 (86,68)	480 (85,56)	1,597 (86,94)	625 (88,65)	461 (86,33)	438 (85,21)	1,524 (86,94)
Household Head's Education								
Not in School / Yet to Attend School	364 (50,00)	260 (47,45)	205 (36,54)	829 (45,13)	357 (50,64)	257 (48,13)	191 (37,16)	805 (54,92)
Elementary - Junior High School	251 (34,48)	187 (34,12)	198 (35,29)	636 (34,62)	242 (34,33)	183 (34,27)	183 (35,60)	608 (34,68)

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Senior High School	78 (10,71)	72 (13,14)	125 (22,28)	275 (14,97)	74 (10,50)	66 (12,36)	113 (21,98)	253 (14,43)
Diploma - Bachelor's Degree	35 (4,81)	29 (5,29)	33 (5,88)	97 (5,28)	32 (4,54)	28 (5,24)	27 (5,25)	87 (4,96)
Household Head's Smoking Status								
No	197 (27,06)	139 (25,36)	160 (28,52)	496 (27,00)	187 (26,52)	138 (25,84)	149 (28,99)	474 (27,04)
Yes	531 (72,94)	409 (74,64)	401 (71,48)	1,341 (73,00)	518 (73,48)	396 (74,16)	365 (71,01)	1,279 (72,96)
Household Income								
Lowest	164 (22,53)	102 (18,61)	108 (19,25)	374 (20,36)	154 (21,84)	101 (18,91)	101 (19,65)	356 (21,31)
Lower-middle	200 (27,47)	135 (24,64)	86 (15,33)	421 (22,92)	197 (27,94)	134 (25,09)	80 (15,56)	411 (23,45)
Middle	188 (25,82)	124 (22,63)	90 (16,04)	402 (21,88)	183 (25,96)	121 (22,66)	83 (16,15)	387 (22,08)
Upper-middle	107 (14,70)	109 (19,89)	149 (26,56)	365 (19,87)	105 (14,89)	106 (19,85)	135 (26,26)	346 (19,74)
Highest	69 (9,48)	78 (14,23)	128 (22,82)	275 (14,97)	66 (9,36)	72 (13,48)	115 (22,37)	253 (14,43)
Personal Income								
Lowest	177 (24,31)	102 (18,61)	92 (16,40)	371 (20,20)	167 (23,69)	101 (18,91)	89 (17,32)	357 (20,37)
Lower-middle	228 (31,32)	134 (24,45)	72 (12,83)	434 (23,63)	224 (31,77)	131 (24,53)	66 (12,84)	421 (24,02)
Middle	163 (22,39)	116 (21,17)	104 (18,54)	383 (20,85)	160 (22,70)	114 (21,35)	95 (18,48)	369 (21,05)
Upper-middle	107 (14,70)	124 (22,63)	161 (28,70)	392 (21,34)	103 (14,61)	119 (22,28)	145 (28,21)	367 (20,94)
Highest	53 (7,28)	72 (13,14)	132 (15,85)	257 (13,99)	51 (7,23)	69 (12,92)	119 (23,15)	239 (13,63)
Pocket Money								
Up to Rp, 30,000	615 (84,48)	1.802 (60,92)	1.230 (50,89)	1.388 (57,91)	601 (85,25)	397 (74,34)	387 (75,29)	1.385 (79,01)
Rp, 30,000 - Rp, 50,000	38 (5,22)	176 (5,95)	405 (16,76)	158 (6,59)	36 (5,11)	37 (6,93)	15 (2,92)	88 (5,02)
Rp, 50,000 - Rp, 84,207	40 (5,49)	321 (10,85)	364 (15,06)	290 (12,10)	37 (5,25)	35 (6,55)	27 (5,25)	99 (5,65)
Rp, 84,207 - Rp, 155,460	20 (2,75)	392 (13,25)	203 (8,40)	330 (13,77)	17 (2,41)	31 (5,81)	53 (10,31)	101 (5,76)
More than Rp, 155,460	15 (2,06)	267 (9,03)	215 (8,90)	231 (9,64)	14 (1,99)	34 (6,37)	32 (6,23)	80 (4,56)
Environment								
Residence								
Rural	357 (49,04)	283 (51,64)	217 (38,68)	857 (46,65)	350 (49,65)	280 (52,43)	199 (38,72)	829 (47,29)
Urban	371 (50,96)	265 (48,36)	344 (61,32)	980 (53,35)	355 (50,35)	254 (47,57)	315 (61,28)	924 (52,71)
School Type								
Private	231 (31,73)	41 (7,48)	47 (8,38)	319 (17,37)	226 (32,06)	41 (7,68)	46 (8,95)	313 (17,86)
Public	497 (68,27)	507 (92,52)	514 (91,62)	1,518 (82,63)	479 (67,94)	493 (92,32)	468 (91,05)	1,440 (82,14)
Psychology								
Not Depressed	643 (88,32)	513 (93,61)	388 (69,16)	1,544 (84,05)	629 (89,22)	502 (94,01)	360 (70,04)	1,491 (85,05)
Depressed	85 (11,68)	35 (6,39)	173 (30,84)	293 (15,95)	76 (10,78)	32 (5,99)	154 (29,96)	262 (14,95)
Total	728 (100)	548 (100,0)	561 (100,0)	1,837 (19,54)	705 (100,0)	534 (100,0)	514 (100,0)	1.753 (95,4)

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Table 2.
Adjusted regression analyses of determinants for smoking initiation and persistense across IFLS waves.

Variable	Initiation			Persistence		
	Wave 3 OR	**Wave 4 OR**	**Wave 5 OR**	**Wave 3 OR**	**Wave 4 OR**	**Wave 5 OR**
	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)
Sociodemographic						
Age						
Early Adolescents	ref.	ref.	ref.	ref.	ref.	ref.
Late Adolescents	2.112 (1.617 - 2.758)***	3.211 (2.344 - 4.398)***	2.215 (1.650 - 2.972)***	2.381 (0.790 - 7.178)	1.734 (0.513 - 5.854)	2.495 (1.066 - 5.840)*
Gender						
Male	ref.	ref.	ref.	ref.	ref.	ref.
Female	0.004 (0.002 - 0.008)***	0.001 (0.000 - 0.006)***	0.006 (0.003 - 0.012)***	0.151 0.024 - 0.962)*		0.039 (0.006 - 0.249)***
Adolescent Education						
Not in School / Yet to Attend School	ref.	ref.	ref.	ref.	ref.	ref.
Elementary - Junior High School	0.712 (0.529 - 0.959)*	1.006 (0.720 - 1.405)	1.098 (0.751 - 1.604)	0.286 (0.034 - 2.398)	1.729 (0.217 - 13.749)	0.839 (0.274 - 2.566)
Senior High School	0.671 (0.459 - 0.980)*	0.812 (0.542 - 1.217)	0.867 (0.580 - 1.296)	0.173 (0.020 - 1.518)	1.152 (0.149 - 8.887)	0.721 (0.200 - 2.594)
Diploma - Bachelor's Degree	0.614 (0.236 - 1.599)	0.751 (0.305 - 1.847)	0.951 (0.419 - 2.156)	0.030 (0.001 - 1.009)	0.334 (0.019 - 5.803)	1.497 (0.156 - 14.355)
School Performance						
Elementary School						
Good (≥ average)	ref.	ref.	ref.	ref.	ref.	ref.
Poor (< average)	1.146 (0.832 - 1.579)	0.824 (0.558 - 1.218)	0.927 (0.700 - 1.228)			
Junior High School						
Good (≥ average)	ref.	ref.	ref.	ref.	ref.	ref.
Poor (< average)	1.192 (0.818 - 1.737)	0.472 (0.146 - 1.524)	1.478 (1.074 - 2.034)*			
Senior High School						
Good (≥ average)	ref.	ref.	ref.	ref.	ref.	ref.
Poor (< average)	1.244 (0.955 - 1.621)	1.972 (0.610 - 6.379)	0.584 (0.425 - 0.803)***			
Employment Status						
Unemployed	ref.	ref.	ref.	ref.	ref.	ref.
Employed	1.553 (1.088 - 2.219)*	1.859 (1.263 - 2.735)**	2.417 (1.510 - 3.870)***	1.282 (0.269 - 6.122)	0.192(0.032 - 1.154)	0.885 (0.241 - 3.249)
Socioeconomic						
Household Head's Employment Status						
Unemployed	ref.	ref.	ref.	ref.	ref.	ref.
Employed	0.746 (0.288 - 1.927)	0.398 (0.122 - 1.292)	1.152 (0.417 - 3.183)			1.731(0.371 - 8.073)
Household Head's Education						
Not in School / Yet to Attend School	ref.	ref.	ref.	ref.	ref.	ref.

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Elementary - Junior High School	0.848 (0.654 - 1.098)	0.786 (0.585 - 1.057)	0.858 (0.634 - 1.160)	0.652 (0.214 - 1.981)	1.454 (0.237 - 8.900)	0.972 (0.402 - 2.349)
Senior High School	0.696 (0.473 - 1.022)	0.611 (0.417 - 0.897)*	0.750 (0.538 - 1.045)	0.870 (0.174 - 4.347)	0.230 (0.039 - 1.367)	0.765 (0.285 - 2.055)
Diploma - Bachelor's Degree	0.895 (0.526 - 1.524)	0.897 (0.488 - 1.650)	0.519 (0.302 - 0.893)*	1.255 (0.081 - 19.554)	1.001 (0.045 - 22.280)	0.303 (0.080 - 1.147)
Household Head's Smoking Status						
No	ref.	ref.	ref.	ref.	ref.	ref.
Yes	1.562 (1.217 - 2.007)***	2.462 (1.850 - 3.277)***	1.866 (1.424 - 2.445)***			
Household Income						
Lowest	ref.	ref.	ref.	ref.	ref.	ref.
Lower-middle	1.426 (1.049 - 1.938)*	1.020 (0.677 - 1.537)	0.736 (0.456 - 1.187)	3.113 (0.779 - 12.445)	0.346 (0.062 - 1.913)	0.118 (0.031 - 0.452)**
Middle	1.229 (0.863 - 1.750)	1.267 (0.807 - 1.988)	0.801 (0.500 - 1.284)	2.473 (0.310 - 19.737)	0.785 I0.128 - 4.829)	0.101 (0.029 - 0.348)***
Upper-middle	1.761 (1.176 - 2.637)**	1.342 (0.850 - 2.119)	0.848 (0.534 - 1.348)	1.303 (0.249 - 6.816)	0.242 (0.051 - 1.148)	0.105 (0.026 - 0.415)**
Highest	2.013 (1.177 - 3.443)*	0.888 (0.523 - 1.506)	0.740 (0.440 - 1.245)	1.289 (0.122 - 13.654)	0.125 (0.017 - 0.913)*	0.098 (0.023 - 0.416)**
Personal Income						
Lowest	ref.	ref.	ref.	ref.	ref.	ref.
Lower-middle						
Middle						
Upper-middle						
Highest						
Pocket Money						
Up to Rp. 30,000	ref.	ref.	ref.	ref.	ref.	ref.
Rp. 30,000 - Rp. 50,000	1.963 (1.136 - 3.394)*	1.299 (0.678 - 2.487)	1.145 (0.485 - 2.705)	0.712 (0.050 - 10.203)	5.577 (0.389 - 79.925)	7.361 (0.688 - 78.766)
Rp. 50,000 - Rp. 84,207	3.299 (1.893 - 5.750)***	1.591 (0.799 - 3.170)	1.017 (0.466 - 2.221)	0.394 (0.026 - 5.892)	4.908 (0.442 - 54.547)	7.343 (1.131 - 47.670)*
Rp. 84,207 - Rp. 155,460	2.373 (1.173 - 4.801)*	2.444 (1.178 - 5.071)*	1.866 (0.852 - 4.090)	0.451 (0.025 - 8.188)	7.271 (0.683 - 77.365)	10.695 (1.710 - 66.872)*
More than Rp. 155,460	3.144 (1.545 - 6.398)**	3.368 (1.509 - 7.516)**	1.943 (0.805 - 4.690)	0.502 (0.021 - 11.957)	18.499 (1.420 - 240.995)*	9.872 (1.090 - 89.391)*
Environment						
Residence						
Rural	ref.	ref.	ref.	ref.	ref.	ref.
Urban	1.153 (0.906 - 1.468)	0.999 (0.758 - 1.317)	1.082 (0.837 - 1.399)			
School Type						
Private	ref.	ref.	ref.	ref.	ref.	ref.
Public	0.793 (0.589 - 1.069)	1.013 (0.627 - 1.636)	0.637 (0.401 - 1.013)	1.214 (0.394 - 3.739)		0.229 (0.046 - 1.131)
Psychology						
Not Depressed	ref.	ref.	ref.	ref.	ref.	ref.
Depressed	1.598 (1.092 - 2.338)*	1.189 (0.671 - 2.105)	1.482 (1.139 - 1.930)**	0.202 (0.069 - 0.588)**	0.264 (0.060 - 1.165)	0.462 (0.225 - 0.946)*

Note: Robust see form in parentheses
*** p<0.001, ** p<0.01, * p<0.05.

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Beyond socio demographic influences, socioeconomic factors also played a significant role. Parental smoking was a strong predictor of adolescent smoking initiation, with adolescents from smoking households having significantly higher odds of beginning to smoke in every survey wave (OR: 1.562 , 95% CI: 1.217 - 2.007), 2.462, 95% CI: 1.850 - 3.277), 1.866, 95% CI: 1.424 - 2.445). Household income showed a complex relationship with smoking behavior; while a higher household income increased the likelihood of smoking initiation in the third survey wave (OR: 1.761, 95% CI: 1.176 - 2.637), it acted as a protective factor against smoking persistence in the fifth wave (OR: 0.101, 95% CI: 0.029 - 0.348)). Similarly, access to greater pocket money was associated with an increased likelihood of smoking initiation in wave three (OR: 3.299, 95% CI: 1.893 - 5.750) and a higher risk of smoking persistence in wave five (OR: 18.499, 95% CI: 1.420 - 240.995) .

Environmental factors, such as place of residence and school type, were examined but did not show significant associations with smoking initiation or persistence. Psychological factors, particularly depression, also influenced smoking behavior. Adolescents experiencing symptoms of depression were more likely to initiate smoking (OR: 1.482, 95% CI: 1.139 - 1.930). However, depression appeared to act as a protective factor against smoking persistence. This suggests that while depressed adolescents were more inclined to experiment with smoking, they were less likely to continue smoking in the long term (OR: 0.202, 95% CI: 0.069 - 0.588).

These findings highlight the multifaceted nature of smoking behavior among adolescents, influenced by sociodemographic, socioeconomic, environmental, and psychological determinants. Understanding these factors is crucial in developing targeted interventions to reduce smoking initiation and promote smoking cessation among young individuals.

4. Discussion

This study examined the determinants of adolescent smoking initiation and persistence during 3 years survey period using data from the Indonesian Family Life Survey (IFLS) across three survey waves (2000, 2007, and 2014). The findings highlight the role of demographics, socioeconomic, environmental, and psychological factors in shaping adolescent smoking behavior.

4.1. Trends in Adolescent Smoking Initiation and Persistence

Our results indicate a general decline in smoking initiation over time, which is consistent with global trends in tobacco control efforts. Despite this decrease, smoking initiation remains prevalent, particularly among late adolescents and males. Meanwhile, smoking persistence was highest in Wave 4 and Wave 3 , followed by a decrease in Wave 5. The slight decline in persistence by 2014 may reflect the impact of evolving tobacco control measures or shifting social norms around smoking. These findings underscore the importance of strengthening both prevention and cessation interventions to reduce smoking rates among adolescents effectively.

4.2. Demographic and Socioeconomic Determinants

Age and gender were significant predictors of smoking initiation and persistence. Late adolescents (17–19 years old) were more lik ely to start smoking compared to younger adolescents,. possiblypossibly due to increased autonomy and social exposure [40]. Males had higher rates of both initiation and persistence. This alignsaligning with previous studies that highlight gender differences in tobacco use, potentially influenced by social norms and peer pressure [41, 42]. Employment status was also a significant factor, with employed adolescents more likely to initiate smoking compared to those who were unemployed. Possible explanations include increased financial independence, exposure to smoking peers in the workplace, or stress associated with employment [43]. Socioeconomic status further influenced smoking behaviors, as adolescents from lower- to middle-income households showed higher rates of smoking initiation. This trend may reflect parental smoking habits, easier access to inexpensive cigarettes, or lower awareness of smoking-related health risks within these communities

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[28, 29, 44]. These findings underscore the multifactorial nature of adolescent smoking behavior, shaped by a complex interplay of demographic and socioeconomic variables.

4.3. Environmental and Psychological Factors

Unlike demographic and socioeconomic determinants, environmental factors such as place of residence and school type did not show a strong association with smoking initiation or persistence. This suggests that smoking behaviors may be more influenced by individual and familial factors rather than broader environmental settings.

Psychological determinants, particularly depression, had a complex relationship with smoking behavior. Adolescents experiencing depressive symptoms were more likely to initiate smoking, possibly as a coping mechanism for stress or emotional distress [45]. However, depression appeared to act as a protective factor against smoking persistence. This finding suggests that depression may lead adolescents to experiment with smoking, it does not necessarily result in long-term tobacco use. Future research should explore the underlying mechanisms behind this relationship to develop targeted interventions for adolescents with mental health concerns.

4.4. Implications for Tobacco Control Policies

The findings from this study underscore the critical need for comprehensive and targeted tobacco control policies aimed at adolescents, particularly during late adolescence—a pivotal period for smoking initiation. To effectively address this public health concern, a multifaceted approach that integrates educational, regulatory, socioeconomic, and mental health strategies is imperative.

4.4.1. Strengthening School-Based Prevention Programs

School-based smoking prevention programs have demonstrated significant efficacy in reducing smoking initiation among adolescents. Evidence suggests that school-based smoking prevention programs are most effective when they utilize interactive, student-centered methods such as peer-led discussions and experiential learning [46]. Meta-analyses confirm that high-intensity, sustained programs conducted by trained educators are particularly effective for reducing smoking initiation in young adolescents [47].

4.4.2. Developing Workplace Interventions for Young Workers

Our findings indicate that employment status is associated with a higher likelihood of smoking initiation. As adolescents enter the workforce and gain financial independence, they may also gain greater access to cigarettes. Implementing workplace-based prevention and cessation programs, particularly in industries with a high proportion of young workers, can help fill this gap. Workplace smoking cessation programs, including group therapy, individual counseling, and nicotine replacement therapy, have been effective in promoting cessation However, participation rates in such programs can be low. Strategies to improve engagement include active communication, manager training to encourage participation, and making programs accessible by offering them at the workplace or nearby and reimbursing time spent [48]. Financial incentives have also been shown to significantly increase long-term smoking abstinence when combined with group training programs [49] .

4.4.3. Addressing Socioeconomic Disparities

Adolescents from lower socioeconomic backgrounds were more likely to initiate smoking, consistent with global evidence.. While increasing tobacco taxes is a widely endorsed strategy to reduce smoking prevalence, its effectiveness in narrowing socioeconomic disparities remains uncertain [50, 51]. Therefore, additional measures are necessary, such as strengthening parental education on the dangers of smoking and enforcing stronger tobacco control policies. Community-based interventions that involve parents and teachers have shown promise in reducing smoking prevalence among adolescents [52].

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4.4.4. Integrating Mental Health Support into Tobacco Preventions

The association between depressive symptoms and smoking initiation highlights the need to integrate mental health considerations into tobacco control efforts. Adolescents experiencing psychological distress may turn to smoking as a coping mechanism. Thus, preventive programs should incorporate screening and early intervention for mental health issues. School-based programs targeting students with symptoms of depression or anxiety have demonstrated promising results in reducing smoking uptake. Promoting adolescent mental well-being more broadly may serve as a long-term strategy for preventing smoking initiation and reducing dependence [53].

Together, these strategies emphasize the need for a holistic, evidence-informed approach to adolescent tobacco control—one that accounts for developmental, social, and structural factors influencing smoking behavior. Such integrated interventions will be essential for achieving sustained reductions in youth smoking and preventing the continuation of tobacco use into adulthood.

4.5. Strengths and Limitations

A key strength of this study is the use of a large, nationally representative dataset spanning multiple years, allowing for the analysis of long-term trends in adolescent smoking behavior. However, some limitations should be acknowledged. First, the self-reported nature of smoking behavior may introduce reporting bias. Second, the study does not account for policy changes or external factors influencing smoking trends. Finally, the study identifies associations between various determinants and smoking behavior, and it, does not establish causal relationships.

5. Recommendations

This study provides valuable insights into the determinants of adolescent smoking initiation and persistence in Indonesia. The findings emphasize the importance of demographic, socioeconomic, and psychological factors in shaping smoking behaviors. Effective tobacco control policies should focus on early prevention, addressing socioeconomic disparities, and integrating mental health support to reduce adolescent smoking rates. Future research should further explore the causal mechanisms behind smoking behaviors and evaluate the impact of existing tobacco control policies on youth smoking trends.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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