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Exposure, access, susceptibility to and use of nicotine and tobacco products among 10-16 year-olds: National cross-sectional survey of 14,232 in-school and out-of-school children in Pakistan

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Abstract

Introduction: Tobacco and newer nicotine products pose significant risks to children. Data is needed on tobacco and nicotine use among children in Pakistan, given the evolving market and lack of regular surveillance.

Methods: We conducted a cross-sectional survey of 10-16-year-olds in Pakistan. Using a multistage stratified random sampling strategy, we planned to recruit 9,000 school children from 180 schools and 4,320 out-of-school children from 72 enumeration blocks. We gathered data on their tobacco/nicotine use, exposure, access, and susceptibility. Descriptive analyses were performed to estimate frequencies and usage patterns.

Results: Between December 2023 and May 2024, 14,232 children were surveyed; one-third were out-of-school, with one-third girls. Overall, 9.1% (95%CI:8.5-9.6) of boys and 7.1% (95%CI:6.3-7.7) of girls reported using nicotine and/or tobacco products. Their use did not differ between school-going (8.3%; 95%CI:7.7-8.9) and out-of-school (8.5%; 95%CI:7.7-9.2) children. Reported use of e-cigarettes (boys=4.3%; girls=3.2%) and nicotine pouches (boys=3.4%; girls=2.7%) appeared higher than smoking (boys=2.1%; girls=0.7%) and smokeless tobacco use (boys=2.7%; girls=2.0%), though no statistical comparisons were conducted. More children stated that they would accept cigarettes (27%) and nicotine pouches (23.4%) than smokeless tobacco (18.5%) and electronic cigarettes (16.7%) when

offered by a friend. A significant proportion could access tobacco shops near their schools (55.4%) and homes (43.1%); and 33.3% indicated they could buy these easily.

Conclusions: In Pakistan, more children reported using e-cigarettes and nicotine pouches than smoking cigarettes, although these differences were not tested for statistical significance. Nonetheless, the observed prevalence underscores the need to regulate these products.

Implications: The findings underscore the need for targeted regulatory actions to address youth use of tobacco and nicotine products in Pakistan. Comprehensive policies should consider restrictions on sales near schools, enforcement of smoke-free laws, and public awareness campaigns to prevent youth uptake and continued use of tobacco and nicotine products. Future research should build on these findings by exploring the social and behavioural drivers of children's nicotine use and evaluating interventions aimed at curbing product accessibility and appeal. This study sets a benchmark for future surveillance efforts and policy evaluations in Pakistan and similar settings.

Introduction

Tobacco smoking significantly increases the risk of asthma in children and may cause early onset of atherosclerosis, which can lead to aneurysms and heart disease.[1] Among children who experiment with smoking, 33-50% become regular smokers.[2] The use of smokeless tobacco also presents risks to children, including oral cancers and dental disorders.[3] With tobacco responsible for over eight million deaths and a loss of more than 200 million disability-adjusted life-years annually,[4] preventing uptake is a public health priority.

According to the most recent estimates, globally 50 million 13-15 year-olds use tobacco.[5] The Global Youth Tobacco Survey (GYTS), conducted at least twice between 1999 and 2018 in 140 countries, revealed that smoking prevalence in this age group declined in 80 countries but remained unchanged in 39 and increased in 21.[6] The data shows that smoking rates have plateaued or increased in many low- and middle income countries (LMICs),[6] underscoring the need for tobacco control policies aimed at better safeguarding children from tobacco uptake or continued use.[7]

Pakistan, the world's fifth most populous country, has one of the youngest populations, with over half under 19 years old. It also bears a high tobacco-related disease burden,[8] with over 160,000 deaths attributed to tobacco in 2017.[9] Despite becoming a signatory to the Framework Convention for Tobacco Control (FCTC) in 2005 and introducing measures such as pictorial health warnings and smoke-free laws, Pakistan faces significant challenges in tobacco control.[10,11] In addition, the tobacco and nicotine landscape has evolved in Pakistan, with the rising popularity of electronic cigarettes and nicotine pouches. Sales of electronic cigarettes in Pakistan are reported to be increasing each year, with Pakistan the fourth-largest nicotine pouch market globally by 2023.[12]

In 2013, 10.7% of Pakistani children aged 13–15 years reported current use of any tobacco product, with prevalence among boys (13.3%) twice that of girls (6.6%).[10] While these figures

declined in 2022 (6.8% overall, 8.5% for boys and 4.4% for girls),[11] we have no information on the use of nicotine pouches. Both surveys[10,11] also excluded out-of-school children, who constitute almost one-third of children in Pakistan.[13]

Tobacco and nicotine use in children remains a significant public health issue. To guide robust policy formulation addressing tobacco and nicotine use in youth in Pakistan, it is crucial to understand the use of conventional (cigarettes, smokeless tobacco) and newer (e-cigarettes, nicotine pouches) products in children. In this paper, we explored the use of tobacco and nicotine products among Pakistani children and their susceptibility to take up these products in future. We also assessed the extent to which they had access to tobacco and nicotine products and were exposed to secondhand smoke.

Methods

Design and sample

We conducted a cross-sectional survey with 10-16-year-old children in school and out-of-school between December 2023 and May 2024. School-going children were recruited from secondary schools, with out-of-school children recruited from community settings. A child was considered out-of-school if they had neither registered for nor attended a formal educational institution in the past 12 months, and indicated that they had no plans to do so. Children transitioning between schools were not included in this category.

We purposely selected nine districts, two from each of the four provinces, plus the Federal Capital Territory of Islamabad (also a district). According to the Pakistan Social and Living Standards Measurement Survey (PSLM) 2019–20,[14] around one-third of children aged 5–16 are out-of-school. The proportion of out-of-school children varies by district and is linked to differences in sociodemographic characteristics. To ensure broad representation, a maximum variation sampling approach was used. Within each province, two districts were purposely selected, one with the highest and one with the lowest proportion of out-of-school children.[14]

Sample size

The sample size was based on assuming an Intraclass Correlation Coefficient (ICC)=0.2 and tobacco susceptibility of 10% (based on GYTS).[10] We set out to estimate use within a 4% margin of error (MOE) within the school-based and community-based components of the survey. Anticipating a response rate of 85% (CLASS II[15] and STOP survey[16]) and considering the cluster design and the proposed subgroup analyses, we estimated to approach 9,000 children within 180 schools selected from 90 circles for the school-based component. A **circle** is a geographical unit defined by the Pakistan Bureau of Statistics (PBS), typically comprising 7–10 Enumeration Blocks (EBs), with each EB consisting of approximately 200–250 households. For the community component, the proportion of out-of-school children at 40%, a 4% MOE, an anticipated response rate of 85% with a design effect of 2 and an average household size of 6.61[17] generated a sample size of 4,320 children within 72 EBs (60 per block).

Sampling strategy for school children

Within all nine districts, a three-stage proportional stratified random sampling approach was used. In the first stage, 90 circles were selected using systematic random sampling with probability proportional to size based on the estimated number of households.[17] In the second stage, 180 schools were selected from the lists of all secondary schools located within the circles. Within each circle, we compiled a list of eligible schools. We used stratified random sampling to recruit two schools within each circle; one boys' and one girls' school. Some circles only had boys' schools; in these cases simple random sampling was used. If the selected circles did not have the required number of secondary schools, additional circles were chosen to reach the quota. At the third stage, 9,000 children were selected using systematic random sampling (50 within each school) from the lists of children studying in each of the five secondary school grades (Grades 6-10). These lists were prepared by schools, and only their registration numbers were shared with the statistician for random selection. Ten children were selected within each grade to ensure coverage across all age ranges. In the case of mixed-gender schools, five boys and five girls were selected within each grade. If enough participants were not recruited from the selected schools because of a low enrolment rate, small school size or parental refusals, an additional school was randomly selected from the list. This process ensured that we recruited at least 100 school-going children from each circle. Three-stage sampling weights were also developed (see supplementary file 1 for further details on weight calculation).

We obtained parental consent on an opt-out basis, and children's assent on an opt-in basis; both were required for study enrolment. The schools sent out the study information packs to parents/guardians of the selected children, containing information sheets and a parent/guardian opt-out consent form. The children's assent forms were administered within the school. If a parent/guardian decided to opt-out of the study or the child did not give assent, another child was randomly selected from the list.

Sampling strategy for out-of-school children

A three-stage proportional stratified random sampling approach was used to select 4,320 out-of-school children across all nine districts. In the first stage, we randomly selected 72 circles from the list of 90 circles selected for the school-based survey. In the second stage, 72 EBs were randomly selected; one from each circle. In the third stage, a household mapping exercise was carried out within each EB (on average, each block consisted of 250 households). An eligibility assessment was carried out based on the presence of out-of-school 10-16 year-old children, and 60 households per EB were randomly selected from those eligible. All out-of-school children residing in these households were selected. If an EB had more than 25 eligible households but fewer than 60, an additional EB within the same circle was randomly selected, and the process was repeated to reach the target of 60. In EBs with 25 or fewer eligible households, the remaining sample was recruited through convenience sampling from within the circle. Three-stage sampling weights were developed for this component of the survey (see supplementary file 1 for further details on weight calculation).

Before approaching selected children and their parents/guardians, community gatekeepers and social mobilisers were identified in each enumeration block. Field supervisors and research assistants were also hired from the same area to carry out the community-based component of the survey. Once identified, they received orientation about the survey, and

after their agreement, they facilitated access to eligible households. The head of the household was briefed about the study and given a study information pack containing an information sheet, opt-out parental consent form and child's assent form. Once the parent/guardian agreed to participate, the child's assent was sought and administered. If the child was not at home at the time of the field team's visit, an appointment was scheduled with the guardian/parents to visit the house again at a suitable time. If the child was working elsewhere and could not be surveyed at home, with the consent of parents/guardians, the child was interviewed at the place of work, after seeking their assent. However, if parents and/or children refused to participate, or after three attempts, there was no response, then another household from the list was randomly selected.

If the household survey did not yield a sufficient sample within an EB, we used additional recruitment strategies. We identified organisations that worked with out-of-school children in the same EB or, if needed, in the same circle. They were contacted, and social mobilisers were identified with their help. These social mobilisers acted as key informants for identifying additional out-of-school children in the community settings (markets where they worked, bus stops, religious institutions, etc.), receiving consent from parents/guardians and scheduling interviews.

Data collection

A pre-tested, self-administered questionnaire in Urdu was completed by children, with their responses directly entered on tablets, facilitated by locally trained field staff. For those out-of-school children who were unable to read, the questionnaire was administered by the field staff. To ensure privacy and validity of the responses, schoolteachers and parents were not to be involved in handling questionnaires, and the field staff stood back during completion.

The questionnaire was based on established instruments (GYTS,[18] CLASS,[19] ASTRA[20]) adapted to the local context. We asked about any use of cigarettes, smokeless tobacco, e-cigarettes, and nicotine pouches (we specifically asked about Velo as this brand dominated the nicotine pouch market in Pakistan) in the last 30 days, the same time-frame used within GYTS. Intention to use was assessed using two questions[21]: the likelihood of using these products in the coming year, and accepting these from friends. Response options were Definitely not, Probably not, I have not thought about it, Probably yes, and Definitely yes, with those responding anything other than Definitely not to either question categorised as susceptible. In addition, we also assessed children's exposure to these products by asking if their family members and friends used these products. Second-hand smoke exposure was assessed by asking if people smoked tobacco (cigarettes) in their presence, inside their homes, schools or outdoors. Their access to these products was assessed by asking if they have tobacco shops in the vicinity of their homes and schools, and the ease with which they can purchase tobacco. The questions on exposure inside schools and access to these products near schools were only given to school children.

The tool was pre-tested with two youth advisory groups (in-school and out-of-school). Ethics approval was obtained from the National Bioethics Committee for Research, Health Research Institute, National Institutes of Health, Pakistan.

Data analysis

Descriptive analyses are used to report sample characteristics (e.g., demographics, socio-economic status) as well as tobacco and nicotine product-related attitudes and behaviours, exposure and access. We reported counts and percentages for categorical variables and means and standard deviations for continuous variables. We estimated frequency and 95% confidence intervals for tobacco and nicotine use, attitudes, perceptions, exposures and other variables. The use of nicotine and tobacco products in past 30 days is presented as bar charts (Figure 1). For each product, the distinction was made between single (using one product only), dual (using of two products), and poly use (using two, multiple or all four products). Estimated use was calculated for males and females and by school status (school-going and out-of-school). We did not apply any statistical tests to detect differences between the use of different nicotine and tobacco products. To ensure national representativeness, multistage sampling weights were developed separately for the school-going and out-of-school children samples. For the school-going sample, weights were calculated across four stages: district, circle, school, and student (grades 6–10). For the out-of-school sample, weights were computed in three stages: selected circles, enumeration blocks, and households with out-of-school children (details provided in supplementary file 1 - Notes on weightage sampling). At each stage, independent selection probabilities were determined, and final survey weights were derived by multiplying the stage-wise weights. We used the STROBE[21] checklist (see Appendix) to report our study.

Results

We approached 211 schools (31 refused) and 72 Enumeration Blocks and surveyed 14,232 children (Table 1): 9,106 boys (64%) and 5,126 girls (36%). Children were 10–16 years old, with 55% among 13–15 year-olds. Across all age groups, 14-year-olds had the highest representation (19.7%). Among all participants, 9,011 were in school and 5,221 out-of-school. The out-of-school children included those who left formal schooling and those who never attended. Some were at home while others were working in various trades. For those in schools, the gender distribution was relatively consistent across grades, with slightly more girls representing grades 7 and 8. Most mothers of participating children (57.3%) and one-third of fathers (35.1%) had received no formal education.

Table 1: Socio-demographic characteristics of the survey participants

	Boys N=9,106 (64.0%)	**Girls** N=5,126 (36.0%)	**Total** N=14,232
Age (years)			
10	537 (5.9%)	384 (7.5%)	921 (6.5%)
11	769 (8.4%)	498 (9.7%)	1,267 (8.9%)
12	1,289 (14.2%)	783 (15.3%)	2,072 (14.6%)
13	1,587 (17.4%)	946 (18.5%)	2,533 (17.8%)
14	1,807 (19.8%)	999 (19.5%)	2,806 (19.7%)
15	1,558 (17.1%)	884 (17.3%)	2,442 (17.2%)
16	1,559 (17.1%)	632 (12.3%)	2,191 (15.4%)
Missing	0	0	0

Education (only school-going children n=9,011; boys=5,563; girls=3,448)			
Grade 6	1,118 (20.1%)	701 (20.3%)	1,819 (20.2%)
Grade 7	1,158 (20.8%)	743 (21.6%)	1,901 (21.1%)
Grade 8	1,166 (21.0%)	742 (21.5%)	1,908 (21.2%)
Grade 9	1,059 (19.0%)	675 (19.6%)	1,734 (19.2%)
Grade 10	1,062 (19.1%)	587 (17.0%)	1,649 (18.3%)
Missing	0	0	0
Mother/female guardian education			
No education	5,426 (59.6%)	2,733 (53.3%)	8,159 (57.3%)
Primary	1,253 (13.8%)	833 (16.3%)	2,086 (14.7%)
Secondary	1,272 (14.0%)	911 (17.8%)	2,183 (15.3%)
Higher education (any level)	769 (8.4%)	545 (10.6%)	1,314 (9.2%)
I do not know	386 (4.2%)	104 (2.0%)	490 (3.4%)
Missing	0	0	0
Father/male guardian education			
No education	3,328 (36.6%)	1,689 (33.0%)	5,017 (35.3%)
Primary	1,552 (17.0%)	760 (14.8%)	2,312 (16.3%)
Secondary	2,339 (25.7%)	1,523 (29.7%)	3,862 (27.1%)
Higher education (any level)	1,548 (17.0%)	1,019 (19.9%)	2,567 (18.0%)
I do not know	339 (3.7%)	135 (2.6%)	474 (3.3%)
Missing	0	0	0
Parents/guardians in an occupation			
Father only	7,379 (81.0%)	4,090 (79.8%)	11,469 (80.6%)
Mother only	300 (3.3%)	238 (4.6%)	538 (3.8%)
Both	1,074 (11.8%)	676 (13.2%)	1,750 (12.3%)
Neither	280 (3.1%)	96 (1.9%)	376 (2.6%)
Not sure	73 (0.8%)	26 (0.5%)	99 (0.7%)
*Wealth Index**			
Low	3,283 (36.1%)	1,544 (30.1%)	4,827 (33.9%)
Middle	3,142 (34.5%)	1,732 (33.8%)	4,874 (34.3%)
High	2,681 (29.5%)	1,850 (36.1%)	4,531 (31.8%)
Missing	0	0	0

*The wealth index was generated using Principal Component Analysis (PCA) based on a set of household asset variables, including flush toilet, television, refrigerator, car, and moped/scooter/motorcycle.

In terms of susceptibility among never-users, approximately one in four children indicated that they would accept a nicotine or tobacco product offered by a friend. More children stated that they would accept cigarettes (boys=29% [95%CI: 28-29.8]; girls=22% [95%CI: 20.4-22.6]) and nicotine pouches (boys=23% [95%CI: 21.8-23.5]; girls=19% [95%CI: 17.6-20-1]) than smokeless tobacco (boys=19% [95%CI: 17.6-94.5]; girls=15% [95%CI:14.3-16.3]) and electronic cigarettes (boys=15% [95%CI: 14.7-16.2]; girls=13% [95%CI:11.7-13.5]). In terms of whether they thought they would start to use nicotine or tobacco products in the next 12 months, approximately one in seven were susceptible. While boys showed similar susceptibility to all four products, girls were more likely to be susceptible to using nicotine pouches (boys=16% [95%CI:15.3-16.8]; girls=12% [95%CI: 11.5-13.4]) and electronic cigarettes (boys=15% [95%CI: [14.6-16.2]; girls=12% [95%CI: 11.3-13.1]) than cigarettes

(boys=17% [95%CI: 14.7-17.9]; girls=11% [95%CI: 9.6-11.4]) and smokeless tobacco (boys=15% [95%CI: 14.7-16.2]; girls=9% [95%CI: 8-9.5]). The sensitivity analysis was conducted on a sub-sample of participants who had never used any nicotine or tobacco product, excluding all ever-users (Table 2).

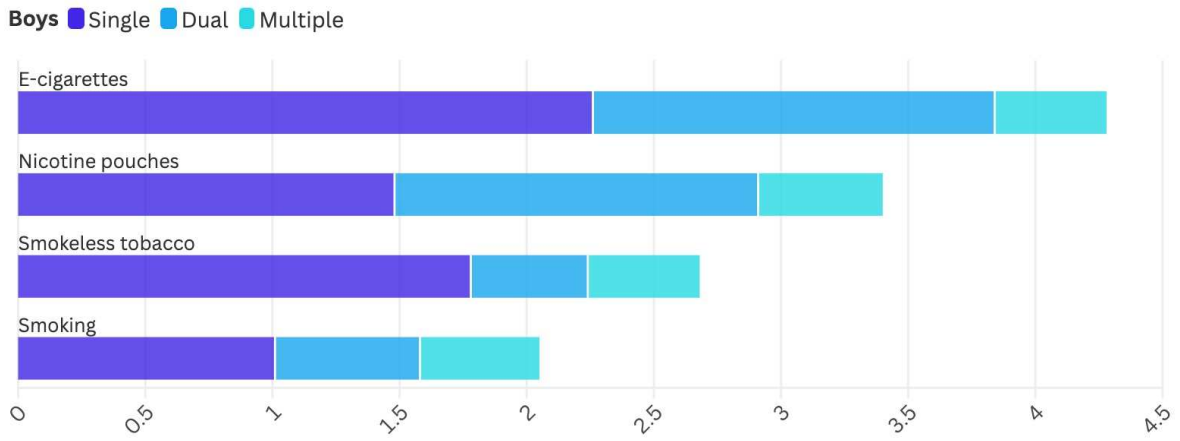
Table 2: Intent and susceptibility – sub-sample of never-users

Variables	**Never-user***		
	Boys *n/N (%) [95%CI]*	**Girls** *n/N (%) [95%CI]*	**Overall** *n/N (%) [95%CI]*
Susceptibility to use cigarettes when offered by a friend	2578/8919 (28.9%) [28 - 29.8]	1095/5091 (21.5%) [20.4 - 22.6]	3673/14010 (26.2%) [25.5 - 26.9]
Susceptibility to use smokeless tobacco when offered by a friend	1654/8862 (18.7%) [17.6 - 94.5]	765/5024 (15.2%) [14.3 - 16.3]	2419/13886 (17.4%) [16.8 - 18.1]
Susceptibility to use nicotine pouches when offered by a friend	1992/8796 (22.7%) [21.8 - 23.5]	945/4988 (19%) [17.6 - 20.1]	2937/13784 (21.3%) [20.6 - 22]
Susceptibility to use e-cigarettes when offered by a friend	1344/8716 (15.4%) [14.7 - 16.2]	624/4960 (12.6%) [11.7 - 13.5]	1968/13676 (14.4%) [13.8 - 15]
Missing	0	0	0
Intent to use cigarettes in the next 12 months	1509/8919 (16.9%) [14.7 - 17.9]	533/5091 (10.5%) [9.6 - 11.4]	2042/14010 (14.6%) [13.7 - 16]
Intent to use smokeless tobacco in the next 12 months	1368/8862 (15.4%) [14.7 - 16.2]	441/5024 (8.8%) [8 - 9.5]	1809/13886 (13%) [12.5 - 13.6]
Intent to use nicotine pouches in the next 12 months	1413/8796 (16.1%) [15.3 - 16.8]	620/4988 (12.4%) [11.5 - 13.4]	2033/13784 (14.8%) [14.2 - 15.4]
Intent to use e-cigarettes in the next 12 months	1339/8716 (15.4%) [14.6 - 16.2]	604/4960 (12.2%) [11.3 - 13.1]	1943/13676 (14.2%) [13.6 - 14.8]
Missing	0	0	0

*Data is presented for the sub-sample of children who have never-used any product, disaggregated by gender and product type, hence the varying denominators.

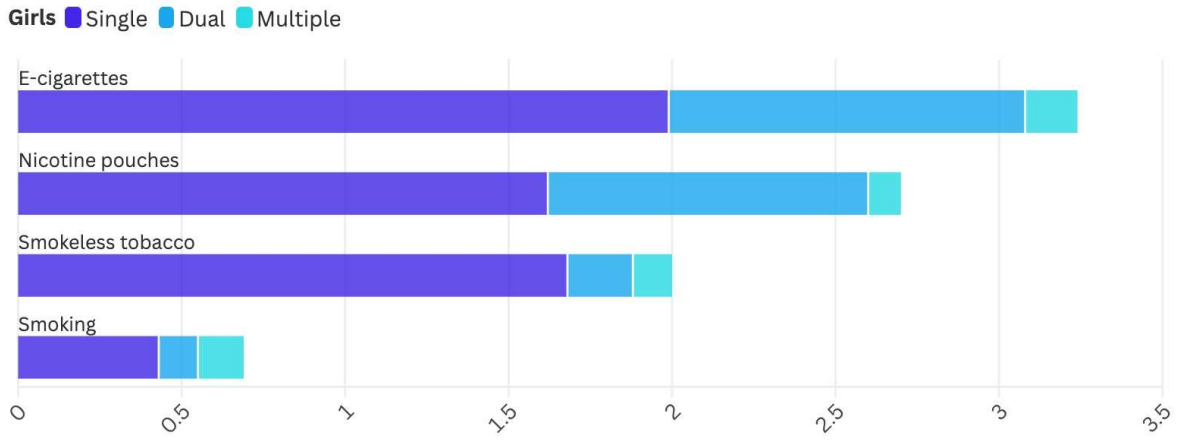
Overall, 9.1% (95%CI:8.5-9.6) of boys and 7.1% (95%CI:6.3-7.7) of girls currently used nicotine or tobacco products, see Figure 1. The use of these products was similar between in-school (8.3%; 95%CI:7.7-8.9) and out-of-school (8.5%; 95%CI:7.7-9.2) children. Use of e-cigarettes (boys=4.3% [95%CI: 3.9-4.7]; girls=3.2% [95%CI:2.8-3.7]) and nicotine pouches (boys=3.4% [95%CI:3.1-3.8]; girls=2.7% [95%CI:2.3-3.2]) was higher than smoking [boys=2.1% [95%CI:1.7-2.3]; girls=0.7% [95%CI:0.4-0.9]) and smokeless tobacco (boys=2.7% [95%CI:2.4-3.1]; girls=2.0% [95%CI:1.6-2.4]). Figure 1 distinguishes between single, dual, and multiple product use: *single use* indicates use of only one nicotine/tobacco product; *dual use* refers to use of two different products; and *multiple use* reflects use of three or all four products. Among current users, single-product use was most common (see supplementary file 2 for table).

Figure 1-a: Use of nicotine and tobacco products in the previous 30 days+ (boys)



Note: +single indicates use of one product only, dual indicates use of two products and multiple could be three or all four products

Figure 1-b: Use of nicotine and tobacco products in the previous 30 days+ (girls)



Note: +single indicates use of one product only, dual indicates use of two products and multiple could be three or all four products

When split by school-going status, a higher proportion of in-school children used e-cigarettes (in-school=4.8% [95%CI:4.4-5.3], out-of-school=2.3% [95%CI:1.9-2.7]) and nicotine pouches (in-school=3.4 [95%CI:2.9-3.7]; out-of-school=2.8% [95%CI:2.3-3.3]) than out-of-school children. On the other hand, more out-of-school children smoked cigarettes (in-school=1.2% [95%CI:0.9-1.4]; out-of-school=2.2% [95%CI:1.8-2.6]) or used smokeless tobacco (in-school=1.8% [95%CI:1.5-2.1]; out-of-school=3.5% [95%CI:3.0-4.0]) than in-school children.

Approximately half reported that at least one family member smoked (50.1%) or consumed smokeless tobacco (44.6%), see Table 3. One in 10 children reported use of nicotine pouches, and one in 20 vaping, among family members. Approximately one in six reported smoking (16.2%) and smokeless tobacco use (15.5%) among friends. One in five children knew about

nicotine pouches and e-cigarettes, and a significant proportion saw them being used by family members or friends.

Concerning second-hand smoke, nearly half (47.1%) reported observing smoking in their homes, 63.7% reported observing smoking outside the house (with large differences between boys and girls; 73.7% vs 46.4%), and one in six (17.3%) reported observing smoking in schools.

Two-fifths of children (43.1%) knew of at least one tobacco shop within five minutes of their homes; the majority of school children (55.4%) knew of at least one shop within five minutes of their school. One in three (33.3) indicated that they could easily buy tobacco, with boys twice as likely as girls to do so (40.6% vs. 20.4%). Of those who purchased cigarettes, the majority (82.9%) purchased single sticks.

Table 3: Exposure and access to nicotine and tobacco products

	Boys (N=9,106) *n (%) [95%CI]*	**Girls (N=5,126)** *n (%) [95%CI]*	**Overall (N=14,232)** *n (%) [95%CI]*
Family member smoking tobacco	4,765 (52.3%) [51.3-53.4]	2364 (46.1%) [44.7-47.5]	7.129 (50.1%) [49.3-51]
Family member using smokeless tobacco	4,283 (47.1%) [46-48.1]	2,066 (40.3%) [39-41.7]	6,349 (44.6%) [43.8-45.2]
Family member using nicotine pouches	854 (9.4%) [8.7-10]	433 (8.5%) [7.7-9.2]	1,287 (9.1%) [8.5-9.5]
Family member using e-cigarettes	440 (4.8%) [4.4-5.3]	254 (5%) [4.3-5.6]	694 (4.9%) [4.5-5.3]
Friend smoking	1,655 (18.2%) [18.4-19]	658 (12.8) [11.9-13.8]	2,313 (16.2%) [15.6-16.9]
Friend using smokeless tobacco	1,609 (17.7%) [16.9-18.5]	605 (11.8%) [11-12.8]	2,214 (15.5%) [15-16.2]
Friend using nicotine pouches	663 (7.3%) [6.8-7.8]	160 (3.2%) [2.7-3.6]	823 (5.8%) [5.4-6.2]
Friend using e-cigarettes	727 (8.0%) [7.5-8.6]	203 (4.0%) [3.5-4.5]	930 (6.5%) [6.2-7]
Observed smoking inside home (7 days)	4,536 (49.8%) [48.8-50.8]	2,163 (42.2%) [40.8-43.6]	6,699 (47.1%) [46.2-47.9]
Observed smoking outside home (7 days)	6,682 (73.4%) [72.5-74.2]	2,391 (46.4%) [45.3-48.0]	9,073 (63.7%) [63-64.5]
Observed smoking in school (7 days)*	1,041/5,563 (18.7%) [17.7-19.7]	5,20/3,448 (15.1%) [13.9-16.3]	1,561/9,011 (17.3%) [16.5-18.1]
Access to tobacco shop in the vicinity of home	4,473 (49.1%) [48.1-50.2]	1,656 (32.3%) [31-33.6]	6,129 (43.1%) [42.3-43.9]
Access to tobacco shop in	3,490/5,563 (62.7%)	1,551/3,448 (45.0%)	5,041/9,011 (55.4%)

the vicinity of schools*	[61.5-64]	[43.3-46.7]	[54.9-57]
Ability to purchase tobacco (easy or very easy)	3,694 (40.6%) [39.6-41.2]	1,044 (20.4%) [19.3-21.5]	4,738 (33.3%) [32.5-34.1]
Missing	0	0	0

*Note: These questions were only asked of school-going children; therefore, the denominators for these variables reflect only that subgroup.

Discussion

We found that among 10-16 year-olds in school and out-of-school in Pakistan, 9.1% of boys and 7.1% of girls reported using a nicotine or tobacco product in the previous 30 days. Consistent with the rising popularity of e-cigarettes and nicotine pouches, their uptake was even higher than tobacco products, especially among girls. E-cigarettes were the most commonly used product, followed by nicotine pouches, smokeless tobacco, and tobacco that is smoked. Twenty percent of children knew about nicotine pouches and e-cigarettes, and many observed them being used by family members or friends.

Our 2024 survey used a slightly wider age range (10-16 years) than the 2013[10] and 2022[11] GYTS (13-15 years) and also included out-of-school children. With these differences in mind, a non-statistical comparison between these studies indicates a significant decline in smoking and use of smokeless tobacco. This is generally consistent with global trends of youth tobacco use.[6] There was some inconsistency however, between what children reported as their tobacco use and that of their peers, given that they indicated that their friends used tobacco more commonly than themselves. While social norms theory[24] suggests that children tend to overestimate such behaviours among their friends, it is possible that they underreported their own tobacco use. Overall use of nicotine products has, however, seen little change given the rise in use of e-cigarettes and nicotine pouches observed in our survey. The increase in popularity of e-cigarettes is consistent with global trends.[6,22-23]

We found high use of nicotine pouches in Pakistan, similar to the trend in the US,[25] where nicotine pouches are the second most popular tobacco and nicotine product after e-cigarettes.[26] Current use of nicotine pouches, at 3.4% among boys and 2.7% in girls, is, however, higher in Pakistan than in the US, at 1.8%,[26] despite the Pakistan market being less mature than that of the USA. While we did not explore reasons for the use of nicotine pouches, an area that warrants research, qualitative research with youth in Australia found that they are perceived to be a 'healthier' alternative to combustible and electronic cigarettes.[27] The situation in Pakistan mirrors the changes taking place in the global nicotine and tobacco market. Ever since its introduction in Pakistan, Velo has been marketed aggressively, often using celebrities to attract youth. This, and the absence of any clear legislation prohibiting the sale of nicotine pouches to children, as well as the likely appeal of these products to youth as they are discreet, are likely to have contributed to their popularity. Many tobacco companies are now focusing on novel nicotine products to maintain their profit margins amidst declining cigarette sales.[28] This transition has led to an evolving nicotine marketplace, one that requires robust regulatory responses.

Half (50%) of children were living with at least one smoker, while a similar proportion (47%) reported being exposed to second-hand smoke indoors. While some overlap is likely, this does not mean that all children living with a smoker are exposed to second-hand smoke indoors. Nearly two-thirds of children reported outdoor exposure to second-hand smoke. These findings indicate that very little stigma is attached to smoking in the presence of children. A high level of second-hand smoke exposure has also been reported in other recent studies from Pakistan.[29] An even higher level of exposure in public places than in homes is also aligned with poor compliance with smoke-free legislations in the country.[30]

We found a significant proportion of children (55%) have shops that sell tobacco near their schools with many (44%) indicating that they can purchase tobacco products with little or no difficulty. This indicates poor compliance with the country laws (Prohibition of Smoking in Enclosed Places and Protection of Non-smokers Health Ordinance, 2002)[31,32] prohibiting tobacco sale near schools and to children.[33] Of those who bought cigarettes, the vast majority (83%) bought them as single sticks. Despite a ban on the sale of single sticks,[31] this practice continues, as also shown in studies in both rural[34] and urban Pakistan.[35] The sale of tobacco products near schools and residential areas remains a key determinant of tobacco use in youth.[36] Global data also indicate common marketing strategies to attract children towards tobacco products, including: displaying tobacco products near sweets, beverages and snacks; advertising tobacco products at children's eye-level; and selling flavoured products and single sticks of cigarettes.[37] Given the proportion of children buying cigarettes in their vicinity and in the form of single sticks, strict enforcement of these laws could potentially make a significant difference in smoking uptake.

A strength of our study is that it is the largest and the only national survey in Pakistan examining the use of tobacco and novel nicotine products and their socio-ecological determinants among children. The survey was stratified for provinces and urban/rural areas and included nicotine pouches. As one-third of Pakistan's children are out-of-school,[13] for the first time, these children were represented in such a survey. Another notable strength of this study was the complete data capture, achieved through a well-structured digital data collection tool and rigorous training of research assistants.

Our study has some limitations. We employed a three-stage proportional random sampling method to select participants; however, the selection of two districts per province was purposive. Although a stratified random sampling approach would have been ideal, the need for maximum variation in the proportion of out-of-school children across districts justified a purposive selection. Fourteen percent of out-of-school children were recruited through convenience sampling, as not all randomly selected EBs had sufficient eligible households. This strategy, although a departure from systematic random sampling, was necessary to achieve our sample size. Although our field manual and training emphasised recording refusals, none were documented. While it's possible all children consented, it is more likely that some refusals, particularly among out-of-school children who may have hesitated due to the illegality surrounding child labour, were not recorded. However, refusals did not emerge as a notable barrier during field discussions, suggesting their number was likely low. Our survey relied on self-reported exposures and behaviours related to tobacco and nicotine products, which we could not verify through biochemical means. To mitigate bias, we ensured that children completed their responses privately and that confidentiality was strictly

maintained. Nevertheless, it is possible that some children refrained from disclosing their use of tobacco and nicotine products due to concerns about being identified. The school- and home-based survey settings may have heightened these concerns. Finally, while our survey questions were drawn from previously validated instruments,[10,17] those addressing e-cigarettes and nicotine pouches were adapted with the assumption that their validity and reliability would be comparable across both nicotine and tobacco products.

Given the popularity of e-cigarettes and nicotine pouches reported in our survey, it is imperative to understand the trajectories of their use and the likely impact among children. Furthermore, implementation research should guide how to enforce legislation on sales restrictions of tobacco products to children and in the vicinity of schools, smoke-free public places and point-of-sale marketing. Legislation should be put in place to regulate novel nicotine products to restrict their marketing and sale among youth. Government, public bodies and civil society should work together to enforce smoke-free bans in public places and restrictions on tobacco sales to young people and their marketing at point-of-sale.

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Declaration of interest
All authors declare no conflict of interest.

Author contributions
AS was a co-investigator on the TAP study and contributed to the study design and interpretation. CM, ZK and LB were co-investigators on the TAP study and contributed to the study design and manuscript review. HR advised on data analysis and reviewed the manuscript. CH was a co-investigator on the TAP study and contributed to study design (including sampling strategy and sample size) and interpretation. AK was a co-investigator and co-lead for the TAP study survey, overseeing its implementation and contributing to the manuscript review. SAK contributed to protocol and tool development and reviewed the manuscript. SA contributed to the study by conducting a comprehensive data analysis for the study. MF contributed to study design (sampling methodology), developed the survey questionnaire, supervised data collection, facilitated SA in analysis and contributed to manuscript writing.

Data availability
Data and the corresponding codebook can be shared upon request

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Supplementary file 1

Technical note on preparation of sampling weights of National cross-sectional survey of in-school and out-of-school children in Pakistan

Sampling strategy for school children

Multistage sampling weights developed for the **school-going children.**

At first stage district level weights were prepared, as two districts from each province selected using Simple Random Sampling (SRS) and Islamabad selected with certainty.

Probability of selection of districts in a province = P_1 = number of selected districts in a province / total number of districts in a province

While, first stage weights = $W_1 = 1/ P_1$

At second stage; Patwar Circle/ Circles from each district selected using Probability Proportional to Size (PPS) method using estimated number of households in a Patwar Circle / Circle as Measure of Size (MOS) with Systematic Random Sampling (SYS). It is noteworthy that Patwar Circles selected from rural area while Circles selected from urban area.

Probability of Section of Patwar Circle/Circle = P_2

Where, P_2 = (Total number of households in a selected Patwar Circles/ Circles as per 2017- Population & Housing Census Sampling Frame) / (Total number of households in all Patwar Circles / Circles of a district as per as per 2017- Population & Housing Census Sampling Frame) * Number of selected Patwar Circles/ Circles

Second Stage weight=$1/P_2=W_2$

At third stage, two schools from each Patwar Circle/ Circles selected using Simple Random Sampling (SRS).

Third stage probability of selection of schools = P_3

Where, P_3 = number of selected schools / total number of schools in a Patwar Circle/ Circle

Third stage weight = $W_3= 1/ P_3$

At fourth stage; children of 10-16 years of age from 6-10 class interviewed. From each school; 50 interviews completed.

Fourth Stage Probability of selection of children= P_4

Where, P_4 = total number of complete interviews / total number of target interviews

The overall probability of selection of children in a sample is

P (School survey) = $(P_1 * P_2 * P_3 * P_4)$

The overall weight of selection of children in a sample is

W_t (school survey) = $1/ (P_1 * P_2 * P_3 * P_4)$

Sampling of Out-of-School children

Multistage sampling weights developed for the **Out-of-School children (household survey).**

At first stage: In pre-selected Patwar Circle/ Circles, certain number of Patwar Circle/ Circles selected using Simple Random Sampling (SRS).

At second stage: Later on, 1-3 enumeration blocks selected from each Patwar Circle/ Circles using Simple Random Sampling (SRS).

At third stage: In selected enumeration blocks, the households having Out of School Children selected for enumeration using Systematic Random Sampling technique (SYS).

Therefore, the **probability of selection of Patwar Circle/ Circle** in pre-selected Patwar Circles/ Circles = P_5

Where, P_5 = (number of selected Patwar Circle/ Circle in a district) / (Total number of pre-selected Patwar Circle/ Circle in a district)

Weight of selection of enumeration blocks= $W_5 = 1/ P_5$

The **probability of selection of enumeration blocks** in selected Patwar Circles/ Circles = P_6

Where, P_6 = (number of selected enumeration blocks in a Patwar Circle/ Circle) / (Total number of enumeration blocks in a Patwar Circle/ Circle as per 2017- Population & Housing Census Sampling Frame)

Weight of selection of enumeration blocks= $W_6 = 1/ P_6$

In selected enumeration block, OOSC household enumerated. The **probability of selection of OOSC** household = P_7

Where, P_7 = Total number of completed OOSC interviews / Total number of target OOSC interviews

The **overall probability of selection of OOSC** in sample

$$P(\text{ household Survey}) = (P_1 * P_2 * P_5 * P_6 * P_7)$$

The **overall weight of selection of OOSC** in a sample

$$= W_t(\text{household survey}) = 1/ (P_1 * P_2 * P_5 * P_6 * P_7)$$

Supplementary file 2

Table (Figure 1): **Use of nicotine and tobacco products in the previous 30 days[+]**

Products	Boys N=9106			Girls N=5126			Overall N=14232		
	Single n (%) [95%CI]	Dua n (%) [95%CI]	Multiple n (%) [95%CI]	Single n (%) [95%CI]	Dual n (%) [95%CI]	Multiple n (%) [95%CI]	Single n (%) [95%CI]	Dual n (%) [95%CI]	Multiple n (%) [95%CI]
Smoking	92 (1.01%) [0.83 - 1.19]	52 (0.57%) [0.43 - 0.71]	43 (0.47%) [0.34 - 0.6]	22 (0.43%) [0.25 - 0.61]	6 (0.12%) [0.04 - 0.20]	7 (0.14%) [0.05 - 0.23]	114 (0.80%) [0.66 - 0.94]	58 (0.41%) [0.33 - 0.49]	50 (0.35%) [0.27 - 0.43]
Smokeless tobacco	162 (1.78%) [1.56 - 2]	42 (0.46%) [0.33 - 0.59]	40 (0.44%) [0.31- 0.57]	86 (1.68%) [1.36 - 2]	10 (0.20%) [0.08 - 0.32]	6 (0.12%) [0.03 - 0.21]	248 (1.74%) [1.58 - 1.90]	52 (0.37%) [0.31 - 0.43]	46 (0.32%) [0.25 - 0.39]
E-cigarettes	206 (2.26%) [1.97 - 2.55]	144 (1.58%) [1.33 - 1.83]	40 (0.44%) [0.31- 0.57]	102 (1.99%) [1.62- 2.36]	56 (1.09%) [0.84 - 1.34]	8 (0.16%) [0.06 - 0.26]	308 (2.16%) [1.98 - 2.34]	200 (1.41%) [1.26 - 1.56]	48 (0.34%) [0.27 - 0.41]
Nicotine pouches	135 (1.48%) [1.24 - 1.72]	130 (1.43%) [1.19 - 1.67]	45 (0.49%) [0.35- 0.63]	83 (1.62%) [1.31- 1.93]	50 (0.98%) [0.74 - 1.22]	5 (0.10%) [0.01 - 0.19]	218 (1.53%) [1.37 - 1.69]	180 (1.26%) [1.11 - 1.41]	50 (0.35%) [0.27 - 0.43]

+single indicates use of one product only, dual indicates use of two products and multiple could be use of three or all four products

Supplementary file 3

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3 (lines 7-10)
Methods			
Study design	4	Present key elements of study design early in the paper	3 (line 15)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3 (lines 15-28)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3 (lines 15-20), 4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5 (lines 25-39)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5 (lines 25-39)
Bias	9	Describe any efforts to address potential sources of bias	9 (lines 38-45)
Study size	10	Explain how the study size was arrived at	3-4, 9 (lines 25-32)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6 (lines 2-19)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6 (lines 2-19)
		(*b*) Describe any methods used to examine subgroups and interactions	6 (lines 8-10)
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	7 (lines 1-2)
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6 (lines 21-23)
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6 (lines 21-29)
		(b) Indicate number of participants with missing data for each variable of interest	N/A Mentioned 0 in tables
Outcome data	15*	Report numbers of outcome events or summary measures	7 (lines 4-20),
-Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6 (Table 2), 7 (Figure 1 & 2)
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9 (till line 23)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9 (lines 25-45)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8 (lines 5-11)
Generalisability	21	Discuss the generalisability (external validity) of the study results	9 (lines 19-23)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10 (Lines 11-13)