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ORIGINAL ARTICLE

Prevalence of adolescent risk behaviors at 11 and 15 years of age: data from the 2004 Pelotas birth cohort

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Objectives: The objective of this study was to investigate the prevalence of the following risk behaviors: experimentation with cigarettes, electronic cigarettes, alcohol, substances, delinquent behavior, and sex at age 15, stratified by sex and socioeconomic position. We also investigated the prevalence of cigarette and alcohol experimentation at age 11 and the persistence and cumulative incidence of these behaviors between 11 and 15 years of age.
Methods: In this cohort study, we included 3,491 11-year-olds and 1,949 15-year-olds from the 2004 Pelotas Birth Cohort. All outcomes were identified via confidential questionnaires and were analyzed as binary variables.
Results: At age 11, there was a higher prevalence of cigarette experimentation among boys. At age 15, there was a higher prevalence of experimentation with alcohol, cigarettes, and substances among girls; experimentation with cigarettes and sex were more prevalent among those in a low socioeconomic position. We found a high cumulative incidence of alcohol experimentation, as well as persistent alcohol experimentation, in both boys and girls.
Conclusions: Further research should clarify causal paths of the high prevalence of risk behaviors during adolescence and its increase among girls.

Keywords: Adolescent; health risk behaviors; population studies in public health

Introduction

Risk behavior is defined as participation in activities that could cause physical and/or emotional harm, including violence, sex, tobacco, alcohol, and illicit substances.[1] Although such activities during adolescence may have an exploratory character, if a consolidated pattern of risky behavior is not identified early and monitored, the individual's health may be harmed.[1] Previous studies have demonstrated that early experimentation with alcohol or substances is associated with later substance use disorder or heavy drinking, which suggests the probable persistence of such behaviors over time.[2,3]

Furthermore, risk behaviors are associated with increased morbidity and mortality (alcoholism, smoking, and deaths due to accidents and violence). In the USA, approximately 10,000 15- to 19-year-olds die every year, mostly from preventable causes related to risk behavior.[4,5] Studies suggest that these behaviors do not occur in isolation. Smoking, the use of alcohol and other substances, risky sexual behavior, and aggressive behavior predict each other.[6-9] The use of e-cigarettes among high school students, for instance, increased the odds of cannabis use.[10]

The leading causes of mortality and morbidity among adolescents in both industrialized and developing nations are limited to a relatively small number of potentially preventable health risk behaviors that often initiate in early adolescence.[11,12] Most research on this issue has been conducted in North America, Australia, and Western Europe.[13,14] Despite the vast literature concerning tobacco and alcohol experimentation in adolescence, Brazilian literature on adolescent risk behaviors is still scarce.[15] To the best of our knowledge, the only population-based survey study about the prevalence of risk behaviors in adolescence in Brazil is the National Adolescent School-Based Health Survey (Pesquisa Nacional de Saúde do Escolar [PeNSE]),[16] whose results are focused on risky behaviors in isolation.[17-21] Furthermore, we could not find a Brazilian study that measured the cumulative incidence or persistence of risk behaviors throughout early adolescence. The literature generally

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describes the continuation of some adolescent risk behaviors into adulthood.[22,23] The present study also aimed to contribute to the growing literature concerning the use of electronic cigarettes in Brazil. Brazil was one of the first countries in the world to ban electronic smoking devices. This ban was motivated by a lack of evidence for the alleged therapeutic properties and harmlessness of these products. The Brazilian Health Surveillance Agency (ANVISA) was criticized for this move, especially by electronic cigarette user groups, who argued that prohibition prevented access to a product that would aid smoking cessation and be less toxic than ordinary cigarettes. It is unclear whether this decision was successful. Available data show that electronic smoking devices have many formulations and may contain toxic substances. Studies in animals and humans have shown potentially toxic effects that also affect the health of passive smokers,[24] and the literature is still inconclusive about whether electronic cigarettes actually help those who want to quit smoking.[25]

The main objective of this study was to investigate the prevalence of the following risk behaviors: experimentation with cigarettes, electronic cigarettes, alcohol, substances, delinquent behavior, and sex at age 15, stratified by sex, family income, and maternal education. We also investigated the persistence and cumulative incidence of cigarette and alcohol experimentation between 11 and 15 years of age. This study can help clarify the extent of risky behaviors in adolescence, providing a broad view of this scenario in Brazil and allowing researchers to follow trends of cigarette and alcohol experimentation over time. The results may provide evidence that could guide future prevention and intervention actions for this population.

Methods

Population and study design

The 2004 Pelotas Birth Cohort was a population-based birth cohort of children born in Pelotas, Rio Grande do Sul, Brazil from January 1, 2004 to December 31, 2004. The population of Pelotas, a city in southern Brazil, is approximately 340,000. More than 99% of all 2004 deliveries took place in hospitals. The study attempted to enroll all births from mothers who resided in the metropolitan area. Researchers accompanied each birth through daily visits to the city's five maternity hospitals. The mothers answered a structured questionnaire on demographic, socioeconomic, behavioral, and biological information, reproductive history, and health care utilization. Trained fieldworkers examined the newborns. All live births (n=4,231) were enrolled in the cohort study. Follow-up assessments were made at home at mean (SD) ages of 3.0 (0.1), 11.9 (0.2), 23.9 (0.4), and 49.5 (1.7) months and at a research clinic at 6.8 (0.3), 11.9 (0.2), and 15.7 (0.2) years, with follow-up rates between 46.1 and 96%.

We included 3,491 11-year-old adolescents and 1,949 15-year-old adolescents from the 2004 Pelotas Birth Cohort. The sixth follow-up wave (at 11 years of age) was conducted between May and October 2015 (follow-up rate: 87%). The seventh follow-up wave (at 15 years of age) occurred between November 2019 and March 2020, when COVID-19 social distancing measures occurred in Brazil, so the data collection had to be interrupted. Thus, only 46.1% of the original cohort was interviewed in the seventh follow-up. Further details about the cohort study and data collection have been published elsewhere.[26-28]

Outcomes

Alcohol and cigarette experimentation were determined according to a self-report questionnaire mailed to the adolescents at age 11 that included the following questions: Have you ever drunk alcohol? Have you ever smoked cigarettes, even one or two puffs? The answers were considered a binary outcome – yes/no.

The following outcomes were identified at age 15 through a confidential self-report questionnaire mailed to the adolescent and analyzed as binary outcomes (yes/no): experimentation with cigarettes, electronic cigarettes, alcohol, substances, delinquent behavior, and sex. The outcomes were identified through the following question(s): Have you ever smoked cigarettes, even one or two puffs?; Have you ever smoked an electronic cigarette?; Have you ever drunk alcohol?; (for girls) Have you ever had sexual intercourse?, Have you ever been pregnant?; (for boys) Have you ever had sexual intercourse?, Have you ever gotten someone pregnant?; At any point in your life, have you ever tried any of the following substances: cannabis, cocaine/crack, amphetamines, inhalants, hypnotics/sedatives, hallucinogens, opiates, etc.?; Have you ever stolen from supermarkets or any kind of business?; Have you purposely destroyed someone else's property?; Have you ever broken into a car to steal something?; Have you ever robbed a car or motorbike in your life?; Have you ever sold illegal drugs to anyone?; Have you ever broken into a house or building with the intent to steal?; Have you ever hit other people to hurt them?; Have you ever instigated or participated in a fight, causing injury to someone else?; Have you ever sold objects you knew to be stolen?; Have you ever stolen money or objects that someone was carrying or using?; Have you ever set fire to or tried to set fire to a school, bus stop, house, etc.?, Have you ever carried a knife or other weapon to protect yourself or use in a fight?; Have you ever used a weapon against another person?; Have you ever participated in a gang?; In the last year, did you get into a fight in which was someone hurt? For variables involving more than one question (experimentation with substances, sex, and delinquent behavior) we created binary variables that were coded positive if at least one question was answered in the affirmative.

Covariates

Information about socioeconomic position (SEP) was collected at the perinatal interview. The socioeconomic and maternal characteristics included family income in the month prior to the child's birth (quintiles) and maternal

education (number of completed years of formal education, categorized as 0-4, 5-8, and $\geqslant$ 9). Data on family income, maternal education, race, age, marital status, parity, smoking and alcohol use during pregnancy, planned pregnancy, the child's sex, low birthweight, and preterm birth were used to compare children included and not included in the study at ages 11 and 15.

Data analysis

Bivariate analysis was conducted to compare characteristics between included and not included adolescents in the sixth and seventh waves. The chi-square test was used for categorical variables and analysis of variance (ANOVA) was used for continuous variables.

We used descriptive analysis to calculate the prevalence and confidence intervals of each outcome stratified by sex, family income, and maternal education. The chi-square test for trend was used to identify differences in the prevalence of cigarette experimentation, e-cigarette experimentation, alcohol experimentation, substance experimentation, delinquent behavior, and sexual experimentation at age 15 according to family income and maternal education in the overall sample and stratified by sex. The cumulative incidence of cigarette experimentation between 11 and 15 years of age was calculated as the proportion of adolescents who reported experimenting with cigarettes at 15 years of age among all those who had denied doing so at 11 years of age. The same procedure was used to calculate the cumulative incidence of alcohol experimentation. Persistent cigarette/alcohol experimentation between 11 and 15 years of age was calculated as the proportion of adolescents who reported experimenting with cigarette/alcohol at age 15 amongst all those who had reported doing so at age 11.

Ethics statement

This study was approved by the institutional review board of the Universidade Federal de Pelotas.

Results

Attrition analysis

The original cohort included 4,231 participants, of whom 98 died by 11 years of age; 3,566 were interviewed at 11 years of age. Outcome data at 11 years of age (cigarette and alcohol experimentation) were available for 3,491 individuals, representing 82.5% of the original cohort. Comparison of maternal and child characteristics at age 11 between adolescents included and not included in the present study are shown in Table 1. The mothers of adolescents included in the study at age 11 were older, highly educated, less likely to be single, and more likely to be in the lowest income quintile and to have smoked during pregnancy than the mothers of those who were not included. In addition, the included adolescents had a higher birthweight and a lower frequency of prematurity than those who were not included.

A total of 1,949 15-year-olds were interviewed before the COVID-19 pandemic interrupted fieldwork. The characteristics of included and not included cohort members are also shown in Table 1. The mothers of adolescents included at age 15 were highly educated, older, and less likely to be in the lowest income quintile. These mothers did not differ significantly regarding parity, marital status (single/non-single), smoking, alcohol consumption during pregnancy, and race (White/non-White). In addition, adolescents included at age 15 had a higher birthweight and a lower frequency of prematurity than those who were not included. There were no sex differences between cohort members included and not included at 11 or 15 years of age.

Prevalence of risk behaviors and sex distribution

At 11 years of age, 49 participants reported experimenting with cigarettes (1.40%) and 279 reported experimenting with alcohol (8%). As shown in Table 2, significantly

Table 1 Comparison of maternal and child characteristics among cohort members included and not included in the present study, 2004 Pelotas Birth Cohort

	At 11 years			At 15 years		
Variables	Included (n=3,491; 82.5%)	Not included (n=740; 17.5%)	p-value[†]	Included (n=1,949; 46.1%)	Not included (n=2,282; 53.9%)	p-value[†]
Family income, lowest quintile	19.5	26.4	< **0.001**	18.7	22.2	**0.001**
Maternal education (years), mean (SD)	9.1 (3.4)	7.7 (3.7)	**0.005**	8.2 (3.5)	7.9 (3.4)	**0.006**[‡]
Maternal race, White	73.0	72.9	0.956	73.4	72.7	0.647
Maternal age (years), mean (SD)	26.2 (6.8)	25.1 (6.5)	< **0.001**	26.6 (6.9)	25.6 (6.6)	< **0.001**[‡]
Single mother	15.6	20.8	**0.001**	15.2	17.4	0.054
Parity $\geqslant$ 2	33.7	37.7	0.082	33.8	34.8	0.052
Smoking during pregnancy	26.7	31.7	**0.008**	26.1	28.6	0.069
Alcohol use during pregnancy	3.2	4.0	0.252	3.6	3.0	0.262
Planned pregnancy	43.6	42.0	0.441	45.5	41.5	**0.010**
Child sex, male	51.6	53.7	0.321	51.1	52.5	0.368
Low birthweight	9.0	15.6	< **0.001**	8.9	11.0	**0.022**
Preterm birth (< 37 weeks)	13.9	18.9	**0.003**	13.2	15.9	**0.036**

Data presented as percentage.
Bold type denotes statistical significance.
[†] Chi-square test.
[‡] Analysis or variance (ANOVA).

Table 2 Prevalence of risk behaviors and sex difference between age 11 and 15, 2004 Pelotas Birth Cohort

	Whole sample		Male		Female		Sex difference
	n	(n=3,491)	n	(n=1,796)	n	(n=1,695)	p-value
11 years of age							
Cigarette experimentation	49	1.40 (1.04-1.85)	33	1.84 (1.27-2.57)	16	0.94 (0.54-1.53)	**0.025**
Alcohol experimentation	279	8.00 (7.12-8.86)	158	8.81 (7.54-10.21)	121	7.15 (5.97-8.49)	0.073
	n	(n=1,949)	n	(n=996)	**n**	(n=953)	p-value
15 years of age							
Alcohol experimentation	1,471	75.47 (73.50-77.37)	701	70.38 (67.54-73.22)	770	80.79 (78.30-83.30)	< **0.001**
Sexual experimentation[†]	683	35.04 (32.92-37.21)	346	34.74 (31.78-37.69)	337	35.36 (32.33-38.40)	0.773
Delinquent behavior	499	25.60 (23.68-27.60)	310	31.12 (28.24-34.00)	189	19.83 (17.30-22.36)	< **0.001**
Cigarette experimentation	383	19.65 (17.91-21.48)	155	15.56 (13.31-17.81)	228	23.92 (21.21-26.63)	< **0.001**
Substance experimentation[‡]	339	17.39 (15.73-19.15)	138	13.85 (11.71-16.00)	201	21.09 (18.50-23.68)	< **0.001**
Electronic cigarette experimentation	210	10.77 (9.43-12.24)	121	12.15 (10.12-14.18)	89	9.34 (7.49-11.19)	**0.045**

Data presented as percentage (95%CI).
Bold type denotes statistical significance.
p-value = chi-square test
[†] If the adolescent's sexual initiation had occurred by the seventh follow-up wave (age 15), sexual experimentation was considered to have occurred.
[‡] Substance experimentation included the following substances: marijuana, cocaine/crack, amphetamines, inhalants, hypnotics/sedatives, hallucinogens, and opiates.

more boys experimented with cigarettes (33 [1.84%] male vs. 16 [0.94%] female, p = 0.025).

At 15 years of age, 1,471 (75.47%) adolescents reported alcohol experimentation, 683 (35.04%) reported sexual experimentation, 499 (25.60%) reported delinquent behavior, 383 (19.65%) reported cigarette experimentation, 339 (17.39%) reported substance experimentation, and 210 (10.77%) reported electronic cigarette experimentation. More girls reported experimenting with alcohol (770 [80.79%] female vs. 701 [70.38%] male p < 0.001), cigarettes (228 [23.92%] female vs. 155 [15.56] male, p < 0.001), and substances (201 [21.09%] female vs. 138 [13.85%] male, p < 0.001), while more boys reported experimenting with delinquent behavior (310 [31.12%] male vs. 189 [19.82%] female, p < 0.001) and electronic cigarette experimentation (121 [12.15%] male vs. 89 [9.34%] female, p = 0.045). There was no difference in sexual experimentation between girls and boys (Table 2).

Prevalence of risk behaviors according to socioeconomic position

Experimentation with cigarettes and sex at age 15 tended to be significantly more prevalent among adolescents in lower income quintiles and among those whose mothers had a lower education level (Table 3). Experimentation with electronic cigarettes, alcohol, delinquent behavior, and substances did not vary according to family income or maternal education level.

Table 4 shows the results stratified by sex. Among boys, lower maternal education levels were associated with a higher frequency of experimentation with cigarettes, substances, and sex at age 15. Lower family income was associated with a higher frequency of sexual experimentation among boys. Among 15-year-old girls, the lower the family income and maternal education level, the higher the frequency of experimentation with cigarettes and sex. The lower the family income, the higher the frequency of delinquent behavior among girls.

Cumulative incidence and persistence of alcohol and cigarette experimentation

Of the 908 boys who reported not having experimented with alcohol at 11 years of age, 72.70% (n=660) had done so by age 15. Of the 917 boys who reported not having experimented with cigarettes at 11 years of age, 16.43% (n=150) had done so by age 15. Among the 874 girls who reported not having experimented with alcohol at 11 years of age, 82.42% (n=720) had done so by age 15. Of the 890 girls who reported not having experimented with cigarettes at 11 years of age, 24.04% (n=213) had done so by age 15 (Figure 1 and Table S1, available as online-only supplementary material).

Of the boys who reported experimenting with alcohol at 11 years of age, 87.50% (95%CI 78.21-93.84) reported doing so at 15 years of age. Of the boys who reported experimenting with cigarettes at 11 years of age, 18.75% (95%CI 4.04-45.65) reported doing so at 15 years of age. Of the girls who reported experimenting with alcohol at 11 years of age, 92.42% (95%CI 83.20-97.49) reported doing so at 15 years of age. Of the girls who reported experimenting with cigarettes at 11 years of age, 25% (95%CI 3.18-65.08) reported doing so at 15 years of age (Figure 1 and Table S1, available as online-only supplementary material).

Discussion

This study revealed that risk behaviors in Brazilian adolescents at 15 years of age were more frequent among girls than boys, except delinquent behavior, which was more frequent among boys, and electronic cigarette use and sexual experimentation, which did not differ according to sex. Our results showed that cigarette

Table 3 Prevalence of risk behaviors at 15 years of age in the overall sample according to family socioeconomic characteristics, 2004 Pelotas Birth Cohort

	Prevalence of risk behavior by family income quintiles and maternal education					
	Cigarette experimentation (n=383)	E-cigarette experimentation (n=210)	Alcohol experimentation (n=1,471)	Substance experimentation (n=339)	Delinquent behavior (n=499)	Sexual experimentation (n=683)
Family income (quintiles)	**p = 0.001**	p = 0.766	p = 0.331	p = 0.450	p = 0.051	**p < 0.001**
Poorest	23.29 (19.04-27.97)	10.14 (7.23-13.70)	74.52 (69.72-78.91)	19.72 (15.77-24.18)	27.40 (22.88-32.28)	41.09 (36.00-46.33)
2nd	23.76 (19.58-28.34)	10.97 (8.08-14.53)	74.78 (69.72-78.91)	16.97 (12.35-21.11)	29.50 (24.98-34.35)	38.90 (33.99-43.99)
3rd	18.18 (14.55-22.28)	12.28 (9.29-15.87)	73.46 (68.89-77.69)	17.20 (13.66-21.22)	23.83 (19.77-28.28)	36.12 (21.44-40.99)
4th	17.59 (14.12-21.52)	10.88 (8.10-14.20)	75.23 (70.88-79.23)	15.04 (11.80-18.77)	24.54 (20.55-28.87)	32.41 (28.01-37.04)
Richest	15.75 (12.15-19.91)	9.39 (6.59-12.88)	78.45 (73.85-82.58)	18.50 (14.64-22.90)	22.92 (18.69-27.61)	26.79 (22.30-31.67)
Maternal education (years)	**p < 0.001**	p = 0.616	p = 0.671	p = 0.192	p = 0.797	**p < 0.001**
0-4	25.99 (20.92-31.60)	10.47 (7.12-14.69)	76.5. (71.09-81.40)	17.69 (13.38-22.70)	23.46 (18.60-28.91)	41.88 (36.00-47.93)
5-8	21.88 (19.06-24.95)	11.64 (9.49-14.09)	73.80 (70.58-76.83)	18.99 (16.31-21.90)	27.59 (24.50-30.85)	40.38 (36.93-43.89)
≥ 9	15.32 (12.99-17.89)	10.14 (8.21-14.34)	76.38 (73.41-79.17)	15.67 (13.31-18.26)	24.54 (21.71-27.54)	27.99 (25.03-31.11)

Data presented as percentage (95%CI).
Bold type denotes statistical significance.
p-value = chi-square test for trend.

experimentation was more prevalent among boys at 11 years of age, but a shift occurred by 15 years of age, becoming more prevalent among girls. We found that lower SEP was associated with higher frequencies of tobacco and sexual experimentation, although the frequency of alcohol experimentation was not influenced by SEP.

Some of the above findings differ from the Brazilian literature, specifically regarding the sex distribution of risk behaviors. For instance, one cross sectional study with adolescents 15-19 years age found no significant differences in tobacco consumption between sexes,[29] and PeNSE 2012, which included Brazilian adolescents aged 13-17 years, reported the same.[17] However, more recently, the international literature, mainly from Europe, shows a higher prevalence of tobacco experimentation among girls aged 16-17 years.[30,31]

Concerning the sex distribution of the other risk behaviors, according to the PeNSE 2012 survey of Brazilian adolescents aged 13-16 years,[18-21] experimentation with substances and sex were more frequent among boys, whereas experimentation with alcohol was more frequent among girls. Our results showed a shift in these behaviors: experimentation with substances was more frequent in girls than boys and sexual experimentation had the same frequency in both sexes. In line with the existing literature, we found that delinquent behaviour[22] and electronic cigarette experimentation were more prevalent among boys.[32]

One important question this study poses is: why would girls be more likely to experiment with alcohol, cigarettes, and substances than boys? Relevant explanations could be related to the social and cultural transformation of society, in addition to individual factors. Traditionally, it has been reported that boys (at age 12) experiment with tobacco more frequently than girls, although in recent years girls have surpassed them.[33] Rogers & Shoemaker's theory[34] about the communication of innovations would be applicable to tobacco and the female collective: young women would still be in the first cycle of the "ascending" curve in tobacco consumption, while young men would be in the second cycle or "descending" curve, which means that men are already quitting tobacco consumption because it is no longer innovative and, since women started later, the smoking prevalence among girls is only now becoming higher. Other social motivations might also partially explain increased tobacco consumption among girls, such as women's greater need to reaffirm themselves in the social domain (specifically in a society that favors men) and the idea that tobacco helps control weight, thus harmonizing with the dominant body image.[35]

Regarding sexual experimentation, the literature, in agreement with our results, indicates a similar prevalence among boys and girls.[36] This equivalence is probably due to societal changes, specifically the feminist movement, which led to greater sexual liberation for women, as well as to the diffusion of contraception.[37]

The epidemiology of experimentation with alcohol and other substances has changed in recent years in most countries. U.S. data show that alcohol and substance use

Table 4 Prevalence of risk behaviors at 15 years of age according to family socioeconomic characteristics stratified by sex, 2004 Pelotas Birth Cohort

	Prevalence of risk behavior by family income quintiles and maternal education					
	Cigarette experimentation	E-cigarette experimentation	Alcohol experimentation	Substance experimentation	Delinquent behavior	Sexual experimentation
Boys	(n=155)	(n=121)	(n=701)	(n=138)	(n=310)	(n=346)
Family income (quintiles)	p = 0.377	p = 0.339	p = 0.620	p = 0.426	p = 0.518	**p < 0.001**
Poorest	19.98 (12.63-24.42)	8.52 (4.85-13.67)	73.25 (65.98-79.71)	16.85 (11.67-23.18)	32.91 (28.93-43.36)	41.38 (33.98-49.08)
2nd	17.68 (12.42-24.03)	13.33 (8.73-19.19)	76.97 (70.08-82.93)	16.02 (11.00-22.19)	35.91 (28.93-43.36)	44.94 (37.49-52.56)
3rd	15.50 (10.79-21.27)	15.15 (10.46-20.92)	68.69 (61.73-75.07)	11.00 (7.02-16.18)	29.65 (23.39-36.51)	39.08 (32.23-46.28)
4th	13.36 (9.13-18.63)	13.42 (9.18-18.71)	72.68 (66.23-78.50)	13.36 (9.14-18.63)	32.25 (26.09-38.92)	30.87 (24.80-37.48)
Richest	16.49 (11.49-22.58)	12.30 (7.96-17.88)	77.96 (71.31-83.69)	14.89 (10.13-20.80)	30.85 (24.33-37.98)	26.74 (20.54-33.69)
Maternal education (years)	**p = 0.003**	p = 0.231	p = 0.987	**p = 0.027**	p = 0.716	**p < 0.001**
0-4	23.85 (16.81-32.11)	14.96 (9.25-22.37)	74.22 (65.74-81.54)	20.00 (13.50-27.91)	29.23 (21.59-37.85)	46.51 (37.69-55.50)
5-8	16.79 (13.20-20.90)	13.28 (10.05-17.09)	73.23 (68.48-77.61)	14.99 (11.58-18.94)	33.16 (28.48-38.10)	42.10 (37.09-47.25)
⩾ 9	12.89 (9.91-16.38)	11.34 (8.53-14.67)	73.85 (69.46-77.92)	12.22 (9.31-15.64)	32.13 (27.79-36.70)	28.25 (24.08-32.71)
Girls	(n=228)	(n=89)	(n=770)	(n=201)	(n=189)	(n=337)
Family income (quintiles)	**p < 0.001**	p = 0.080	p = 0.999	p = 0.756	**p = 0.008**	**p = 0.004**
Poorest	29.94 (23.30-37.27)	12.50 (8.00-18.31)	83.43 (77.07-88.61)	23.86 (17.78-30.86)	23.73 (17.67-30.69)	44.57 (37.07-52.26)
2nd	31.22 (24.69-38.34)	9.68 (5.83-14.87)	82.79 (76.59-87.92)	19.05 (13.71-25.38)	25.40 (19.36-32.22)	37.10 (30.14-44.47)
3rd	21.39 (15.94-27.71)	10.10 (6.28-15.17)	83.16 (77.17-88.12)	23.76 (18.07-30.24)	18.81 (13.67-24.89)	34.82 (28.26-41.85)
4th	23.15 (17.53-29.57)	8.91 (5.37-13.72)	83.17 (77.29-88.05)	17.64 (12.67-23.58)	17.65 (12.68-23.58)	35.96 (29.36-42.97)
Richest	15.57 (10.43-21.97)	6.63 (3.35-11.55)	83.23 (76.69-88.56)	23.35 (17.16-30.51)	14.97 (9.93-21.30)	28.15 (21.47-35.61)
Maternal education (years)	**p = 0.001**	p = 0.814	p = 0.597	p = 0.971	p = 0.177	**p < 0.001**
0-4	29.93 (22.41-38.34)	7.41 (3.61-13.20)	86.67 (79.75-91.90)	16.91 (11.03-24.29)	19.71 (13.41-27.36)	42.10 (33.60-50.97)
5-8 y	28.42 (23.94-33.24)	10.90 (7.93-14.50)	81.50 (77.18-85.31)	24.15 (19.93-28.77)	23.62 (19.44-28.21)	42.06 (37.03-47.22)
⩾ 9	18.45 (14.82-22.53)	9.29 (6.66-12.53)	83.17 (79.19-86.66)	19.85 (16.11-24.03)	17.19 (13.68-21.18)	28.81 (24.49-33.44)

Data presented as percentage (95%CI).
Bold type denotes statistical significance.
p-value = chi-square test for trend.

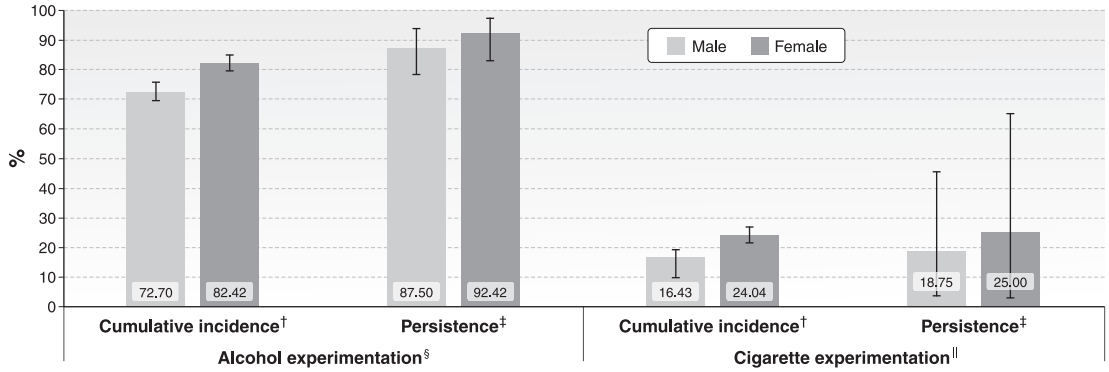

Figure 1 Cumulative incidence and persistence of alcohol and cigarette experimentation between 11 and 15 years of age. † n=1,782 adolescents with complete data regarding alcohol experimentation at 11 and 15 years of age (908 males; 874 females); ‡ n=1,807 adolescents with complete data regarding cigarette experimentation at 11 and 15 years of age (917 males; 890 females); § Cumulative incidence of alcohol experimentation between 11 and 15 years of age were calculated as the proportion of adolescents who reported experimenting with alcohol at 15 years of age among those who denied doing so at 11 years of age. The same procedure was used to calculate the cumulative incidence of cigarette experimentation. || The persistence of alcohol experimentation between 11 and 15 years of age was calculated as the proportion of adolescents who reported experimenting with alcohol at 15 years of age among those who reported doing so at 11 years of age. The same procedure was used to calculate the persistence of cigarette experimentation.

in adolescent girls has increased significantly over the past 30 years,[36] and, in line with our results, is more prevalent among girls.[38,39] Women experience more societal disapproval and are more stigmatized for substance use.[35] The fear of stigma may result in lower rates of substance use and abuse among women or in underreporting, and differences between boys and girls may be due to information bias. On the other hand, in countries where the cultural and family context is extremely sexist, boys experience less pressure to not drink and may even be encouraged to drink on certain occasions (e.g., celebrations), while girls may be encouraged to drink due to negative factors (e.g., traumatic experiences, depression). In these societies, alcohol experimentation is more prevalent in boys.[40]

There are conflicting results about alcohol experimentation among adolescents in the literature. PeNSE 2012 found an increase in alcohol consumption among adolescents with increasing age.[18] Another Brazilian cross-sectional study, comparing two cohorts between 2000 and 2011, reported that alcohol experimentation among adolescents $<$ 14 years of age has significantly decreased: reported alcohol experimentation was 28% less frequent among adolescents in 2011 than 2001.[41] In agreement with this, a Finnish study reported a decrease in drinking and drunkenness among both sexes between 2000 and 2011.[42] However, we found a high cumulative incidence and persistent rates of alcohol experimentation between ages 11 and 15, which is alarming.

A high prevalence of alcohol experimentation at 11 years of age has been previously reported in both sexes in Brazil.[43] Risk factors associated with early alcohol experimentation were family strife and parental example, as well as access to other drugs. To the best of our knowledge, no Brazilian study has analyzed the profile of adolescents who continue to consume alcohol after early experimentation. Malone et al., using longitudinal data on U.S. youth aged 12-19 years, reported that boys and girls had the same rate of alcohol experimentation, but that boys tended to drink less than girls after their first use, which is in line with our results.[44]

Various social mechanisms mediate increased drinking among women: the stress of women's dual roles, social interaction between men and women working together, and change in the position of alcohol as a symbol of gender roles. Sex differences in drinking behavior still remain largely unexplained, even though they have been linked with a number of biological differences between men and women, of female and male cultures, of gender-specific roles, and of ways in which societies regulate drinking.[45]

Early experimentation with alcohol implies neurobiological risks, including a higher propensity for dependence and association with other psychopathological conditions. The Brazilian school-based study Cardiovascular Risks in Adolescents (Estudo de Riscos Cardiovasculares em Adolescentes [ERICA]),[46] which included 73,399 adolescents 12-17 years of age, found that the prevalence of psychological distress was 70% higher among those who consumed alcohol in the last month. The literature has extensively demonstrated a positive association between antisocial conduct disorders and drug and alcohol use.[47] Depression has also been described as a risk factor for substance use in boys.[48]

Both cross-sectional[49] and longitudinal[50] studies have indicated that the age of drinking onset is one of the strongest predictors for later alcohol-related problems, such as alcohol abuse and drug dependence in adulthood. From a neurobiological perspective, the most affected brain regions during this transitional period are the prefrontal cortex, the mesolimbic dopamine system, and its connections to the forebrain.[51]

Given the important role of these brain areas in reinforcing the effects and motivational salience of alcohol and other drugs, it is suggested that the adolescent brain

is particularly vulnerable to the progression of neural changes underlying addiction.[52]

The prevalence of alcohol, tobacco, and illicit substance use among adolescents is staggering. Thus, another important question that this study poses is: how do Brazilian adolescents gain access to illicit substances? And how can the high prevalence of tobacco and alcohol consumption be explained if both are prohibited in adolescents? Peers appear to have a major influence on the initiation and progression of alcohol, tobacco, and marijuana use among adolescents. Factors such as the use of alcohol and other drugs, involvement in academic issues at school, aggression, rebelliousness, and antisocial behavior by friends have been associated with the use of alcohol and other drugs. Thus, peers are an important source of access to drugs.[53] The literature also highlights the household environment as a source of access to tobacco and alcohol. A survey of undergraduate students in northern Brazil demonstrated that tobacco and alcohol use was higher among those who had smokers/drinkers in the family than among those who did not.[54]

Regarding the prevalence of electronic cigarette experimentation among adolescents, high levels have been observed in countries where e-cigarettes are authorized.[25] Data about the use of electronic cigarettes in Brazil is limited but indicates that 4.6% of adult smokers have tried or used electronic cigarettes in the last 6 months.[55] Another study with university students revealed that 2.7% had tried, and 0.6% regularly used electronic cigarettes.[56] Our study revealed a high prevalence of e-cigarette experimentation – 10.8% of the cohort had already tried e-cigarettes at 15 years of age.

Finally, it is remarkable that only two of the six analyzed risk behaviors were significantly influenced by SEP in both sexes: experimentation with cigarettes and sex. The prevalence of experimentation with alcohol and other substances, e-cigarettes, and delinquent behavior was not influenced by SEP in either sex. The frequency of alcohol experimentation was not influenced by SEP, even when stratified by sex. These findings are controversial compared to the literature. For instance, unlike our results, Torikka et al.[42] found that although alcohol use is generally decreasing among adolescents, the likelihood of frequent drinking was higher among adolescents with parents who were unemployed and had low education levels. Regarding tobacco experimentation and SEP, a Brazilian survey found that the lower the socioeconomic class, the higher the odds of experimenting with tobacco.[17] However, other studies found no significant differences in the prevalence of cigarette experimentation according to SEP[27] or even found an inverse association: adolescents with a low SEP reported less tobacco use than those with higher SEP.[28]

There is controversy in literature concerning sexual experimentation and SEP. For instance, Langille et al.[57] found that although sexual risk behaviors are seldom associated with SEP in girls, they are in boys. In Youth Risk Factor Survey data, associations were found between greater parental education levels, living in a two-parent family, and a lack of sexual experimentation among both among boys and girls.[58] Lammers et al.,[59] who studied more than 26,000 adolescents in the U.S., found a strong association in both sexes between a lack of sexual intercourse and higher parental income. Our findings demonstrated an association between lower SEP and sexual activity in both boys and girls. However, we understand the importance of highlighting the association between early sexual experimentation and lower SEP as a possible indicator of other risk behaviors. For example, lower SEP has been shown to be a risk factor for teen pregnancy in many ecological studies,[60] and a lower education level is associated with giving birth before age 20 in Canada.[61] Other studies found higher frequencies of chlamydia infection among lower-income adolescents.[62] Health care workers should be aware that many factors can affect risky behavior in adolescents, modifying the influence of SEP. Both the media and peer pressure may positively or negatively contribute to attitudes toward sex among adolescents. Open and receptive parental communication can positively contribute to better sexual health education.[57]

These controversial findings concerning SEP and risk behaviors may be due to the different measures used to construct the SEP index. Since measures of SEP in low and middle-income countries may differ from those used in high-income countries, comparing findings between different countries must be parsimonious.[63] Our study used maternal education and family income as measures of SEP, and they were obtained from primary data collection rather than government sources, which minimizes the risk of bias.[63]

Our study's strengths include: 1) a large population-based sample, which contributes to the generalizability of the results; the Pelotas cohort is the largest population-based birth cohort study to have been conducted in any low- or middle-income country, involving nearly four decades of work, more than 20,000 individuals studied throughout life, regular assessments during childhood and adolescence, and small follow-up losses; 2) outcome assessment using structured and confidential forms, which allowed access to data regarding experimentation with psychoactive substances and e-cigarettes (which are illegal in Brazil; 3) its contribution to the literature regarding the prevalence of risk behaviors in adolescence and, particularly, the persistence and cumulative incidence of certain risk behaviors between 11 and 15 years of age, as yet undescribed in the Brazilian literature. Nevertheless, this study also has limitations: 1) the interruption in data collection during the COVID-19 pandemic may have led to selection bias that could have affected the results. As in the attrition analysis, families with less purchasing power were excluded. We believe that since more privileged participants were included in our study, our results tend to be more conservative. Thus, the prevalence of risk behaviors was probably underestimated, which highlights the need for greater attempts to control and prevent risk behaviors in adolescence; 2) due to the binary nature of the questions, we were unable to quantify the consumption of tobacco, alcohol, or other substances; 3) due to a lack of information, this study did not reveal how adolescents gained access to illicit substances.

We observed a high prevalence of consumption of alcohol and other substances, which are forbidden by law in the study population. Further research should clarify the factors associated with risk behaviors in adolescence to prevent their high prevalence in both sexes and the progressive increase in alcohol, cigarette, and substance experimentation among girls. The high persistence and cumulative incidence of alcohol experimentation require stricter measures to control the sale of alcoholic beverages to adolescents. Policies to regulate the alcohol market and prevent early consumption should be accompanied by continuous effectiveness assessments. We also detected a positive association between low SEP and higher frequencies of tobacco and sexual experimentation. Thus, health policies should focus on families and adolescents with lower SEP to reduce the risk of early sexual and tobacco experimentation, as well as the medium- and long-term consequences of these behaviors.

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Disclosure

The authors report no conflicts of interest.

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