Risk Factors for Cardiovascular Diseases in School-going Adolescents between 13 and 17 Years

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Abstract

Introduction: Some authors have been able to determine that cardiovascular disease has its origins in early life stages and that the risk of suffering them is determined by the effect associated with exposure to cardiovascular risk factors over a long time, all of which produce a negative effect on the quality of life.

Objective: We aimed to identify cardiovascular risk factors in schooled adolescents within public institutions of education in Villavicencio.

Methods: This was a cross-sectional, prospective, observational study developed in eight high schools with children between 13 and 17 years old. A written standardised survey was applied (questionnaire type), which was auto-administered from the instrument denominated Global School-based Student Health Survey (GSHS) of the World Health Organisation (WHO). The modules were physical activity, eating behaviour, and drugs and alcohol consumption. In addition, the researchers took measures of weight, size, waist circumference, blood pressure and blood tests to measure total cholesterol, high-density lipoproteins (HDL), low-density lipoproteins (LDL), triglycerides and glucose, with each student's informed consent and that of his or her guardian. Statistics

used were: average, standard deviation, interquartile ranges, proportions, Chi-square, and logistic regression.

Results: A total of 1 504 students were analysed. Age and physical activity were not significantly associated with cardiovascular risk.

Conclusions: The results allow us to establish that the predominant risk factors for cardiovascular disease in young adolescents between 13 and 17 years old school in high school in Villavicencio are: smoking, alcohol consumption, body mass index (BMI), and family antecedents (such as precursor pathologies and chronic renal insufficiency), the latter with a risk opportunity of 15.5 times of having cardiovascular disease in this population group.

Keywords: risk factors; adolescents; cardiovascular diseases; eating behaviour; obesity; sedentary behaviour

Introduction

Cardiovascular diseases are the principal cause of disability and early death in the world (Hernández-Martínez et al. 2020). Each year, more people die from any of these diseases than from any other cause, and these are usually observed in men and women of mature or advanced age. However, they start in childhood and evolve gradually in an asymptomatic way during adolescence and youth (García-Rada, Cardona-Hernandez, Roque 2009) until adulthood.

Scientific evidence suggests that cardiovascular disease has its origin in the early ages of life and that the risk of suffering from it is determined by the synergistic effect resulting from exposure to cardiovascular risk factors over time (Ferreira-Guerrero et al. 2017). In Colombia, from the end of the 1960s onwards, cardiovascular diseases started being recognised as a cause of morbidity and mortality. During the next 30 years, cardiovascular diseases have been among the first five on the list of the 10 principal causes of mortality in Colombia (WHO 2017). According to the 2015 national survey on the nutritional situation, nine out of 10 (86.9%) students in Colombia did not comply with the requirements for fruit and vegetable consumption as recommended by the WHO. At least 74% of the surveyed minors drank sugary drinks; 47,3% ate fried food at least once daily; 46% of kids who answered anonymously reported not engaging in significant physical activity during the day, and they even spent three hours a day to stealthily watch television or play videogames (Departamento Administrativo para la Prosperidad Social et al. 2015).

On the other hand, the survey found that the use of tobacco increased with age among students, from 4.7% in the group between 12 and 15 years, up to 13% in the group between 17 and 18 years. Among the scholars between 12 and 14 years, 26,6% of them declared the use of alcohol within the preceding 30 days, and results indicate a rise to 50.5% among students between 17 and 18 years. Altogether 11% of the Colombian

scholars declared having used illegal substances in the previous year (Ministerio de Justicia y del Derecho 2016).

The concern is that these non-transmissible diseases are preventable when controlling risk factors possibly associated with the occurrence of diseases such as a cardiovascular event (George, Tong, and Bowman 2017, 2; Ortiz-Galeano et al. 2022; Visseren et al. 2022, 3235). The study that directed this article intended to identify the cardiovascular risk factors in schooled adolescents at public institutions of education in the city of Villavicencio, Columbia.

Methodology

Design and Location of Study

This was a cross-sectional, prospective, observational study in a sample of 1 504 schooled adolescents between 13 and 17 years, inclusive of both genders. The data were collected in 2019 in eight public institutions of high school education in the municipality of Villavicencio. Prior authorisation was obtained of the school directives, and a voluntary form of participation was completed by participants under the signature and informed consent of parents or guardians.

Sample Size Estimate

The size of the sample was calculated starting from the concept of complex designs and consideration of its selection in achieving an equally likely sample, with the following formula of complex samples:

$$n = N * Z\alpha 2 \, p*q * DEFF2 \,/[(N-1)\,d2 + Z\alpha 2 \, p*q]$$

Where p is the prevalence of any risk factor for cardiovascular disease, and DEFF is the effect associated with the use of a complex design.

The parameters within which the previous formula was applied are:

- N=3602, which constitutes the sampling frame of students in eight schools in Villavicencio (socioeconomic stratum).
- P=prevalence of the consumption of fried food=47.3% of adolescents between 13 and 17 years old. According to the national survey of the nutritional situation (ENSIN 2015), adolescents consume fried food at least once daily.
- Zα2=1.962, with a level of confidence of 95%.
- d=error of sampling or precision of 2.5%.

According to DEFF=1.4, a report that documents the effects of the design for 37 different variables in 48 surveys of Demographic and Health Surveys (DHS), most of

the design effects were between 1.0 and 2.0 and the average design effect was 1.49 (Verma, Lê, and Le 1996).

The result of the sample (n) is 1 504 adolescents.

Once sampling was established, the researchers opted for a sampling of stratified two-stage clusters. At the first stage, the unities of the first stage (UPE) were separated according to defined strata for each of the eight participating schools that were on each course or grade. Previously, it was distributed proportionally as per the number of conglomerates per grade and school. These conglomerates were extracted randomly according to groups or conglomerates formed for each course in each school through a map.

The determination of the number of students to consider in the subsample paraclinical was made through "proportional assignment of each school and conglomerate." This guaranteed to have an individual in each conglomerate simultaneously, while picking up the characteristics of one school, one grade and the proportionality of the school's size, together with "a swing" of the variability of the interest event, influenced by the principal factors that can explain this event.

Criteria of Inclusion and Exclusion

Inclusion criteria were: adolescents between 13 and 17 years, both genders, enrolled in public institutions of education (mega schools) day shift, and currently in grades 6 and 11 or high school of the municipality of Villavicencio urban and rural area for the year 2019.

The exclusion criterium was: adolescents with any disease diagnostic.

Instrument

The Global School-based Student Health Survey (GSHS) validated by the WHO was used as a diagnostic tool for determining cardiovascular risk (Ministerio de Salud Y Protección Social 2016; Verma et al. 1996).

Variables

Analysis variables were age, gender, body mass index (BMI), blood pressure, smoking and alcoholism, obesity, physical activity, eating behaviour, drug consumption, lipid levels (total cholesterol, triglycerides), and blood lipoproteins. Researchers also measured high-density lipoproteins (HDL), low-density lipoproteins (LDL), very low-density lipoproteins (VLDL), and serum levels of blood glucose. These were defined as abnormal levels of total cholesterol, triglycerides (TG), LDL-c, HDL-c and glucose values ≥200 mg/dL, ≥130 mg/dL, ≥130 mg/dL, according to the American Academy of Paediatrics (Giménez-García et al. 2016). The samples were centrifuged the same day

they were collected, and the sera were kept at a temperature of -80ºC to be processed later.

In taking the anthropometric data like weight, size, and anthropometric classification of the nutritional state and waist circumference, the methodology recommended in Resolution 2465 of 2016 (Ministerio de Salud y Protección Social 2016) was used. A waist circumference ≥90 percentile (for age and gender) (Pajuelo-Ramírez et al. 2016) is considered obesity and abdominal obesity (Velásquez, Páez, and Acosta 2015, 31). Having taken into account international recommendations, the hypertensive adolescent was classified as one with systolic or diastolic blood pressure ≥95 percentile, according to age, gender and size (Guzman-Limon and Samuels 2019).

Blood Parameters

Quantification of glucose analytes (TC, HDL, LDL and TG) was made in the autolysed chemistry analyser A-15 of the commercial house Biosystems' clinical laboratory, Blanca Cecilia Osoria Cañas (LABCO), through Biosystems colorimetric techniques. In patients with triglycerides lower than 400 mg/dl, the LDL was calculated through the Friedewald formula: LDL=total cholesterol-HDL cholesterol- (triglycerides/5). With triglyceride concentrations above this value, the LDL cholesterol was quantified by direct measure.

Identification of bias through the logistic regression model factors associated was determined according to factors proposed by Fleta Zaragozano et al. (2008).

Out of the seven proposed factors, it was determined that age and gender are confusing factors for each of the relations of the other five factors, and within the confounders, the age is not statistically significant (p=0.452). However, by deleting it from the model, it alters more than 10% of the OR effects of the other factors with respect to cardiovascular risk, and because of this, it was decided to leave it in the model as a confusion factor that adjusts the effect of the other factors with respect to cardiovascular risk.

Data Analysis

To complete the missing information in certain variables of interest and explain the cardiovascular risk in adolescents, we proceeded to utilise the imputation techniques of Medina and Galván (2007, 19) through the use of the module "multiple imputation" of the IBM SPSS Regression 20 software. In the collected data it was incomplete in an average 14% of the variables, which made it necessary to complete the variables data such as age, gender, family clinical history, tobacco, alcohol, insufficient school exercise (at least 2 hours weekly), and above percentile 75 BMI, which are all factors associated with cardiovascular risk in adolescents. This same strategy of imputation was used to complete the missing data of the lipids results for the variable "abnormal cholesterol" (total or LDL), which was created with "Yes" for the values of total cholesterol over the 200mg/dL, or having LDL values over the 110mg/dL.

The data were captured using Epi-Info, and exported to the statistical software SPSS version 25, licensed by the Universidad de los Llanos, as was used in the statistical trial of Kolmogorov Smirnov, under the void hypothesis (Ho) stating that the variables have a normal distribution, taking as a significant value p≤ 0.05. The numeric variables with parametric distribution were expressed with average and standard deviation, and not the parametric with the mean and the interquartile ranges. The qualitative variables were summarised as proportions.

For the categorical variables, the Chi-square test was used, and multivariate analysis was used to evaluate associations between variables and cardiovascular risk events, and the risk factors through logistic regression (IBM). In addition, it was adjusted with the possible confusion factors of the model, constructed with the relevant factors of nutrition and physical behaviour, and with them, the bivariate analysis had a significance value of p ≤0.2.

Ethical Considerations

This research was approved by the ethics committee of the Universidad de los Llanos, in ordinary session No. 7, on August 21, 2019, under the regulations of Resolution 8430 of 1993 of the Ministry of Health of the Republic of Colombia. This determines the scientific, technical and administrative norms to carry out research related to health, where this research is classified as harmless because no therapeutic intervention or intentional modification was carried out in the biological, physiological or social aspects of participants. Informed consent was given and signed by the participant and the parent or guardian.

Results

From a total of 3 602 adolescents between 13 and 17 years, who were enrolled in eight public schools, 1 504 participants were included in the study. The mean age of the participants was 14.9 ± 0.07 ages (DE=1.4), and 61.9% were female. The students interviewed belonged to a mega school centre with a greater predominance in the urban area of Villavicencio (80.6%). Most of the interviewees were in eighth grade(29.3%), and the minor participation was from seventh-grade pupils (9.7%). With respect to ethnicity, 96.7% expressed belonging to an "other ethnic group," followed by Afro-descendants, with the participation of less than 1%, and indigenous scholars (0.6%). Regarding affiliation to a health regimen as beneficiaries, 34.9% had a subsidised health plan, but 40.4% did not know to which health plan their parents belonged.

It is significant that 9% (136 students) had a paid job despite being minors (only 3 of them had turned 18 years old).

Table 1: Classification of body mass index BMI by gender

Variables	Total population (N=1514)	Masculine (n=589)	Feminine (n=925)
Categorisation of BMI in adolescents	N(%)		
Thinness	33(2.2)	21(3.6)	12(1.3)
Risk of thinness	133(8.8)	70(11.9)	63(6.8)
Normal weight	947(62.5)	342(58.1)	605(65.4)
Overweight	316(20.9)	117(19.9)	199(21.5)
Obesity	85(5.6)	39(6.6)	46(5)

Source: Data of the survey GSHS applied to students

The BMI mean for the study group was 21.42 ± 0.18 kgs/mts^2 (DE=3.6). In a state of observation and care for intervention, 2.2% classified as "thinness" and 5.6% classified as "obesity," which means one out of every five students, and 20.9% are "overweight," with weight problems, in general, at 28.7%. The "thinness" results are almost equally distributed by age until 16 years old. Regarding "overweight," there were 34.3% situated in the 12-year-old group, and regarding "obesity," the age group with the highest percentage was 14-year-olds (9.2%).

In relation to lifestyles, inadequate eating habits were present in at least 76% of the study population; 89.7% had had at least one soft drink in the previous 30 days. However, 82.7% had had at least one fruit in the previous 30 days; 84.8% ate fried foods; 76.3% drank sugary drinks; 76% ate packaged foods; and 44.2% added salt to meals once they were served. Regarding tobacco consumption, 17.9% had tried a cigarette at some time in their life; 8.8% of them did so at age 7 or less, corresponding to 1.5% of the total number of students. They smoked for the first time between 14 to 15 years, followed by the group between 12 and 13 years; 63.6% were in these two age groups, which is equivalent to 11.4% of the total number of students.

Regarding alcohol consumption over the previous 30 days of the survey, 40.9% stated that they had had some liquor ranging from less than one drink (9.1%), one drink (12.9%) to 5 drinks or more (4.2%), which they got mainly through their friends (10.4%) and their family (10.3%). Regarding the consumption of psychoactive substances, 7.9% of them had used marijuana in their lives and 5% in the previous 30 days. This indicates

that 64% who tried marijuana at some point in their lives had continued to consume it in the previous 30 days. Moreover, 4.6% had used amphetamines or methamphetamine. As age increased, the frequency of drug use increased, except for 14 or 15-year-olds, which was the age range in which the highest frequency of drug use occurred, with 3.3%.

Table 2: LDL and total cholesterol classification

Variables	Total population (N=1503)
	N(%)
Normal	1067(71.0%)
Col: 200–220; LDL: 110–130	106(7.1%)
Col: 221–230; LDL: 131–160	12(0.8%)
Col: 231–280; LDL: 161–190	151(10.0%)
Col: >281; LDL: >191	167(11%)

Source: Frequency and percentages by joint classification of cholesterol in the sample according to imputation

The paraclinical results taken from the subsample of students determined that 71% were in the "normal" range in both results, summarised jointly for total cholesterol and LDL. The results determined as "abnormal" were classified with 12.2% of the total in figures of total cholesterol between 200 to 220 mg/dL, or with LDL cholesterol with figures of 110 to 130 mg/dL. The other 11% of the students had "abnormalities" above the previous figures that classified them into more critical categories for possible dyslipidaemia.

Table 3: Factors associated with cardiovascular risk adjusted by gender in adolescents attending school

Variables	OR Crude	OR Adjusted	Sig.	I.C. 95% for OR	
				Inferior	Superior
Clinical family history (1)	15.5	121.5	0.000	12.3	1195.5
Cholesterol (Total o LDL) (1)	4.5	42.1	0.000	7.9	223.7
Be above the 75th percentile of BMI (1)	3.4	14.6	0.001	3.1	69.6
Smoke tobacco or consume alcohol 2 times a month (1)	4.5	*	0.000	2.1	9.8

Source: OR adjusted for gender

*See table 4

Of the seven factors evaluated, four of them were significant for the association with cardiovascular risk; smoking and alcohol consumption (p=0.000); abnormal cholesterol (combined between total and LDL with p=0.000); students with a BMI above 23.3 or 75% percentile; and students with a family history (precursor pathologies to kidney failure chronic with p=0.000), the latter with an association crude OR of a 15.5-fold chance of having cardiovascular risk for students with a family history. Age and physical exertion were not statistically significant to be associated with cardiovascular risk in this crude analysis.

The OR measurements described below should be understood as the OR value of the established association adjusted for age and gender (p=0.000).

The variables "smoking" or "consuming liquor" are defined as when they consume tobacco (3 or more days per month) and or consume alcohol (have consumed 1 or more days per month) (p=0.000). It has been established that consuming tobacco and or alcohol regularly, exacerbates cardiovascular risk in adolescents by 4.6 times compared to those who do not smoke or consume alcohol (p=0.000). However, when stratified by age, it was found that for those over 15 years of age inclusive, this risk rises to 6.1 with a confidence interval between 2.2 and 17.4; for those under 15 years of age, the risk decreases by almost half to 3.1, although the latter is not statistically significant (p=0.055).

Table 4: Measure of association of smoking or alcohol consumption and cardiovascular risk discriminated by age

Variables	Sig.	OR	I.C. 95% para OR	
			Inferior	Superior
Smokes tobacco or consumes alcohol (Crude)	0.000	4.6	2.1	9.9
Under 15	0.055	3.1	0.9	10.1
Over or equal to 15	0.000	6.1	2.3	17.4

Discussion

The objective proposed for this study was achieved. Cardiovascular risk factors in adolescents between 13 and 17 years, schooled at public institutions of education in the city of Villavicencio, were identified. The relevance lies in constituting a useful tool to create prevention strategies and early intervention within an institutional level that tend to strengthen health-promoting behaviours in order to have a positive impact on the health status and quality of life of this population group.

Due to their lifestyle, adolescents can impact their health condition until adulthood (Giménez-García et al. 2016). Similarly, these participants constitute a group that (for their age) may expose themselves to cardiovascular risk (Escudero-Lourdes et al. 2014). Even though in this study "age" was not found to be significant, it was included as a confounding factor because, together with gender, there were variables that adjusted the model of the associated factors to cardiovascular risk. Moreover, it is important to clarify that age has been reported as one of the variables related to the prevention of cardiovascular problems in adolescents (Dzubur, Gacic, and Mekic 2019; Jacobs et al. 2022). In that sense, it is still a variable that should be included in these types of studies.

In this study, the lack of physical activity was a significant factor associated with cardiovascular risk. This lack of physical activity was associated with having 15 times more cardiovascular risk compared to those adolescents who exercised two or more hours weekly (p=0.002). This coincides with the study completed by Lavielle-Sotomayor et al. (2014), where the lack of exercise was a significant factor for adolescents' cardiovascular risk, as well as other authors who mention a strong relation (Flores-Paredes 2017; Lavielle-Sotomayor et al. 2014; WHO 2017).

In addition, it was significant that having a BMI above >23,31 kg/m2 (above the 75% percentile) may present a cardiovascular risk (p=0.001). This is similar to the results obtained in other studies, where researchers reported significance before the BMI equal to or greater than 25 kg/m2 and having cardiovascular risk (Bryce-Moncloa et al. 2017, 4; Cardona-Gomez 2019, 41). Also, it was observed in this study that, similar to reports in other studies, less physical activity and more BMI were found, and this refers to a higher risk of presenting cardiovascular problems in adolescents (Carrillo-López et al. 2020, 117; Flores-Paredes 2017; Tapia-Serrano et al. 2020, 6).

This could also be related to the consumption of foods with a high caloric value by the young people sampled, in addition to their tendency to maintain a sedentary lifestyle (Carrillo-López et al. 2020, 117; Ferreira-Guerrero et al. 2017; WHO 2017). Apart from bad eating habits, in the laboratory tests applied to some of the young people sampled, a tendency to dyslipidaemia was evidenced, which suggests, according to Núñez and collaborators (2009), not only a cardiovascular risk but also having other health problems in the future, such as atherosclerotic cardiovascular disease (ACD). This means that a sedentary lifestyle, obesity, and having abnormal cholesterol were significant factors associated with cardiovascular risk, as reported by Jiménez (2015) in his study on the main factors of cardiovascular risk in young people. The significance of having total cholesterol higher than 200 mg/dL, or cholesterol LDL higher than 110 mg/dL and the associated cardiovascular risk is evidenced in a study by Farias et al. (2018), which indicated that a cholesterol LDL over 110 mg/dL is significant not only for cardiovascular risk, but also for metabolic syndrome in adolescents (Farias et al. 2018).

It has been emphatically shown that having abnormal cholesterol, being sedentary, and consuming substances such as tobacco and alcohol, increase cardiovascular risk (Farias et al. 2018). The results obtained in this study show that most students do not consume the mentioned substances; however, most of them were considered passive smokers due to their families or friendships. Additionally, few young people who expressed consuming these substances, mostly obtained them from family or friends (Telumbre-Terrero et al. 2019, 62; Uroz-Olivares 2018). There is also support for the finding that the consumption of tobacco and alcohol is a significant factor for cardiovascular risk in the studies by Kris-Etherton et al. (2022) and Pajuelo-Ramírez et al. (2016). Tobacco and alcohol are now regarded as the first and second psychoactive substances most consumed by adolescents (Martínez Torres et al. 2018; Ministerio de Justicia y del Derecho 2016), and their consumption should be considered a priority problem to solve in adolescents. The use of these substances, together with presenting abnormal cholesterol and a sedentary lifestyle, could lead to other health impairments, not only CVR (Giménez-García et al. 2016; Otto 2021; Sung et al. 2022).

In addition to the above consideration, it was shown that having a clinical family history is a significant factor associated with cardiovascular risk (p=0.000). This significance is supported by different studies, where it was found that obesity, hypertension and

mellitus diabetes may be hereditary diseases leading to this risk (Escudero-Lourdes et al. 2014; Ramírez-Velez et al. 2017). The sedentary lifestyle habits and the consumption of highly caloric foods may be influenced by family members to adolescents (Nuñez de Sansón 2009; Pajuelo-Ramírez et al. 2016), which explains why young people maintain those prejudicial habits.

To finalise, most young sampled children were classified as having medium to high cardiovascular risk. This can be explained based on the significant variables already mentioned, because all of them may lead to this risk (Dzubur et al. 2019; Giménez-García et al. 2016; Ramírez-Velez et al. 2017). Based on the findings of this study, we recommend joint work between educational institutions and caregivers to encourage physical activity and healthy eating habits in adolescents since these interventions have been reported as effective in reducing these habits that are harmful to health (Farias et al. 2018; Giménez-García et al. 2016). Likewise, it is suggested to intervene psychologically with these young people and their family environment in order to prevent the consumption of substances such as tobacco and alcohol. In this way, it could be prevented that these habits, along with poor nutrition and a sedentary lifestyle, take root in young people as influenced by their families. This would establish bases to prevent future health risks in them and promote a healthy lifestyle in their adulthood.

Recommendations

Taking into account that cardiovascular diseases have their beginnings in childhood and adolescence, the results of this research are relevant since they constitute a baseline that allows the strengthening of strategies and proposals at the local and regional levels. The study endeavoured to impact the planning and execution of interventions related to modifiable risk factors, which will allow the educational community (parents, teachers, students) to promote self-care and the development of healthy habits and behaviours.

Cardiovascular diseases may be prevented with individual commitment, support and follow-up in order to achieve significant changes in lifestyle, which are necessary to maintain cardiovascular health. Nursing professionals should lead prevention programmes in which self-care is the key to dealing with cardiovascular disease:

- Promote adolescent consultation for the identification and timely monitoring of cardiovascular risk factors and the implementation of an intervention plan that generates the adoption of healthy lifestyles and self-care practices.
- Strengthen the implementation of a national strategy for a healthy educational environment, contributing to the strengthening of skills, values, aptitudes, attitudes and capacities of the educational community to care for themselves, others and the environment.
- Propose strategies to the directives of school institutions, such as promoting physical activity within daily occupations, based on personal tastes and interests, and implementing physical activity breaks and classroom rotation

within school days, which will result in a daily increase in physical activity and proper use of free time.

- Promote the implementation of nutritional projects in educational institutions, in which the nursing profession (as part of an interdisciplinary team) develops strategies for communication, information and education that empower teenagers and young people to embrace healthy lifestyles and self-care practices.

Conclusion

It can be concluded that the predominant risk factors for cardiovascular disease in adolescents and young people between the ages of 13 and 17, schooled at high schools in the city of Villavicencio, are: gender, tobacco and alcohol, BMI, and family background. It is necessary to consider the need for early intervention regarding their lifestyles because there is a misconception that cardiovascular diseases (CVD) occur in adulthood. Adolescents and their carers are forgetting that an increase in the consumption of saturated fats, the lack of physical activity (as a result of the actual culture of playing videogames and watching television), the consumption of alcohol and tobacco at an increasingly younger age, and the consumption of foods rich in sodium are practices that start from childhood. Based on the findings, it is emphasised that there is an urgent need to raise awareness in the communities about the relevance of knowing the clinical family history since, in this population group, this factor was significantly associated with cardiovascular risk. Diseases such as obesity, hypertension and diabetes mellitus, which in serious scientific studies have been determined as hereditary risk factors, continue to be reaffirmed with unhealthy eating habits, starting from the school stage, since these are acquired at a very early age, and they are taught from home.

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