PHARMACIA

Pharmacia 73: e204525
DOI 10.3897/pharmacia.73.e204525

Research Article

A pre–post evaluation of pharmacist-led education on adolescents' self-reported medication-related knowledge and perceptions of medicine safety

Jana Urbankova[1], Stanislava Kosirova[1]

1 *Comenius University Bratislava, Faculty of Pharmacy, Department of Pharmacology and Toxicology, Odbojarov 10, 83232 Bratislava, Slovakia*

Corresponding author: Stanislava Kosirova (stanislava.kosirova@uniba.sk)

Received 18 June 2026 ♦ **Accepted** 12 October 2026 ♦ **Published** 26 October 2026

Citation: Urbankova J, Kosirova S (2026) A pre–post evaluation of pharmacist-led education on adolescents' self-reported medication-related knowledge and perceptions of medicine safety. Pharmacia 73: e204525. https://doi.org/10.3897/pharmacia.73.e204525

Abstract

An online pharmacist-led educational session on safe medicine use was evaluated in adolescents aged 15–18 years using pre- and post-intervention questionnaires (n = 122 paired responses). Self-reported confidence in knowledge about medicines increased following the intervention in both boys and girls. Changes in safety perceptions were less consistent. The perceived safety of prescription medicines was higher at the post-intervention assessment, particularly among girls, whereas no significant overall change was observed for OTC medicines. Among girls, however, the perceived safety of OTC medicines also increased slightly. OTC medicine use was common (89.3%), and 15.6% of adolescents reported use without parental awareness. These findings suggest that a brief educational session may be followed by changes in self-reported knowledge, while perceptions of commonly used OTC medicines may remain relatively stable. Overall, targeted and repeated educational approaches may be needed to address everyday medicine use in adolescents.

Keywords

adolescents, education, knowledge, medication literacy, medication safety

Introduction

The global increase in medication use among children and adolescents is becoming an important public health concern (Almunef et al. 2019; Herzig et al. 2022). Studies suggest that young people often have only a basic and sometimes inconsistent understanding of medicines, may hold inaccurate expectations about their effects, and do not always understand when and why they should be used (Dawood et al. 2015; Bakaruddin et al. 2022; Syofan et al. 2023). This is particularly relevant in the context of self-medication, which is increasingly common and often associated with the frequent use of over-the-counter (OTC) products (Herzig et al. 2022).

Limited knowledge, combined with low awareness of potential risks, can lead to serious consequences, including medication-related intoxications (Melo et al. 2022) and other forms of misuse or inappropriate use (Abraham and Chmielinski 2018; Sakai et al. 2019). These behaviours may increase the risks associated with pharmacotherapy

Copyright *Urbankova J & Kosirova S.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

PENSOFT

during adolescence and can persist into adulthood, as patterns of medicine use are often established during this period (Levin et al. 2015).

Another important issue is how adolescents obtain information about their medicines. Although parents are usually the main source (Hämeen-Anttila et al. 2006; Dawood et al. 2014; Kelly et al. 2018), their knowledge is often incomplete or insufficient (Boztepe et al. 2016; Klimaszova et al. 2018b). As a result, adolescents frequently look for information online, including on forums and social media, where the quality of information is highly variable and not always reliable, which may contribute to negative health outcomes (Aston et al. 2019). Even though many adolescents consider their knowledge to be sufficient (Shehnaz et al. 2014), they often do not discuss medication use with their parents in more detail (Kelly et al. 2018).

At the same time, the online environment may also encourage risky behaviours related to medicine use. For example, challenges such as the 'Benadryl challenge' or the 'paracetamol challenge', originally reported in the United States, have also been observed in other countries, including Slovakia, and may encourage the misuse of medicines (Murdock 2020; Horák 2022).

In response, various educational activities aimed at improving knowledge about the safe use of medicines have been developed in different countries. These range from short-term school-based interventions in the United States to more structured, long-term programmes included in school curricula, for example, in Finland and Japan (Siitonen et al. 2014; Recchiuti et al. 2018; Sakai et al. 2019). As adolescents become more independent in their use of medicines, access to clear and practical information is essential to support the development of safe and responsible habits. For this reason, targeted educational interventions during adolescence are increasingly emphasised. Improving medication literacy may support more appropriate and safer use of medicines both in the short and long term. Health literacy has also gained importance at the policy level, with European initiatives and international organisations highlighting its role in public health (Schaeffer et al. 2023). Despite this growing focus, relatively little is known about how brief, pharmacist-led educational interventions influence adolescents' perceptions of medicine use in real-world school settings (Khanal et al. 2025). Existing studies suggest that school-based interventions vary widely in their design and effectiveness, and evidence on pharmacist-led approaches in adolescent populations remains limited (Abraham and Chmielinski 2018; Smith et al. 2021).

The aim of this study was to evaluate changes in adolescents' self-reported knowledge about medicines and their perceptions of medicine safety following an online pharmacist-led educational session. In addition, the study explored whether these changes differed by sex and age and examined the association between parental communication and supervision of medicine use.

Methods

Study design and participants

This exploratory single-group pre/post-intervention study was conducted among adolescents aged 15–18 years attending four secondary schools in Bratislava, Slovakia, between February and March 2021. The study evaluated short-term changes in adolescents' self-reported knowledge about medicines and perceptions of medicine safety following a pharmacist-led online educational session. Because no control group was included, the study design does not allow a clear distinction between the intervention effect and potential testing effects, temporal influences, or social desirability bias.

The inclusion criteria were: (i) age 15–18 years; (ii) current enrolment in a school in Bratislava where the language of instruction was Slovak; and (iii) provision of informed consent to participate in the study and complete the questionnaires. Vocational schools were not included.

The exclusion criteria were: (i) enrolment in a vocational school; (ii) expressed disagreement with participation; (iii) inability to match pre- and post-intervention questionnaires; (iv) duplicate or triplicate submissions; (v) questionnaires completed during the pilot session; (vi) questionnaires completed outside the study timeline; and (vii) questionnaires submitted by respondents outside the predefined age range.

Ethics and anonymity

The study was conducted in accordance with the principles of the Declaration of Helsinki. Under the framework of Slovak Act No. 576/2004 Coll., applicable at the time of data collection, prior ethics committee approval was not considered applicable to this school-based educational study. Data collection took place during the COVID-19 pandemic, when participating schools were operating through distance education, and adolescents completed the online questionnaires remotely from home as part of their online school activities. Permission to conduct the study was obtained from the directors of all participating schools. Before data collection, information about the study was distributed to parents or legal guardians through the participating schools, and they were given the opportunity to decline their child's participation. Participation was voluntary. Before accessing the questionnaire, adolescents were informed about the study aims, the voluntary nature of participation, and the handling of the collected data and provided electronic informed consent before completing the questionnaire. No directly identifying personal information was collected. Participants generated their own identification codes solely to enable matching of the pre- and post-intervention questionnaires.

Study outcomes

The primary outcomes were changes in adolescents' self-reported knowledge about medicines and changes in

their perceptions of medicine safety following the educational session. Self-reported knowledge about medicines referred to adolescents' perceived confidence in understanding medicines, including their purpose, correct use, and potential risks. Perception of medicine safety referred to adolescents' views on how safe prescription and over-the-counter (OTC) medicines are and whether they should be used cautiously and with appropriate guidance.

Questionnaire development and adaptation

The questionnaires used in this study were based on a previously validated instrument developed by Klimaszova et al. (2018a). Specific items relevant to the aims of the present study were selected, and the response options were modified to improve interpretability after permission had been obtained from the original authors. The modified questionnaire was not independently revalidated, and this should be considered when interpreting the findings.

Three questionnaires were used: (i) a pre-intervention questionnaire, (ii) a post-intervention questionnaire, and (iii) a voluntary feedback questionnaire evaluating the educational session. The pre-intervention questionnaire included demographic characteristics and items related to adolescents' knowledge and attitudes towards medicines. The post-intervention questionnaire focused on the same core domains to assess changes after the educational session.

Likert-scale items were answered using five response options: 'strongly agree', 'agree', 'undecided', 'disagree', and 'strongly disagree'. For statistical analysis, these responses were coded from 1 to 5, with lower values indicating stronger agreement.

Online administration of questionnaires

The questionnaires were created in Microsoft Forms and distributed through online learning platforms, primarily Microsoft Teams. Participants accessed the questionnaires via a hyperlink or QR code. The online format reduced incomplete responses and allowed direct export of responses for further processing. Only paired questionnaires that could be reliably matched between the pre- and post-intervention assessments were retained in the final analytical dataset.

Educational intervention

The educational content was prepared by pharmacists in collaboration with teachers and a pilot group of students to align expert recommendations with the informational needs of adolescents. The intervention addressed key topics related to medicines, including definitions of medicines and active substances, distinctions between prescription medicines, OTC medicines, and dietary supplements, and the basics of medicine development. Additional topics included reliable sources of medicine-related information, frequently used medicine groups (e.g. analgesics, antihistamines, cough medicines, nasal preparations, and antibiotics), adverse effects, medicine misuse, antibiotic resistance, drug interactions, overdose, and the risks associated with combining medicines with alcohol.

A pilot online session involving four female secondary school students was conducted before the study to test the clarity, timing, and technical aspects of the intervention. The final educational session lasted approximately 70 min and was delivered online by a pharmacist using Zoom, Microsoft Teams, or Google Meet, depending on school preference. The intervention sequence included an introduction, completion of the pre-intervention questionnaire, the educational presentation, completion of the post-intervention questionnaire, and a brief discussion period.

Questionnaire completion and analytical sample

A total of 183 adolescents completed the pre-intervention questionnaire, and 163 completed the post-intervention questionnaire. Participant-generated identifiers were first used to establish unambiguous one-to-one pre–post matches. Duplicate or triplicate submissions and questionnaires without a corresponding questionnaire at the other assessment were resolved at this stage, resulting in 129 unambiguously matched pre–post pairs. Eligibility criteria were then applied to the matched dataset, resulting in 122 paired questionnaires included in the final analysis. Questionnaires were excluded due to unsuccessful matching, duplicate participant identifiers, pilot testing, completion outside the study period, or failure to meet the age eligibility criteria. Because only paired questionnaires were retained in the final analytical dataset, baseline characteristics of excluded participants were not available for formal attrition analysis.

Statistical analysis

Categorical variables are presented as counts and percentages. Likert-scale responses were treated as ordinal variables and are reported as medians and interquartile ranges (Q1–Q3), with lower scores indicating stronger agreement. Overall pre- and post-intervention differences in the paired sample were assessed using the Wilcoxon signed-rank test. The Mann–Whitney *U* test was used only for comparisons between independent groups, including comparisons between boys and girls. Effect sizes for the Wilcoxon signed-rank test and Mann–Whitney *U* tests were calculated as $r = |Z|/\sqrt{N}$, where N represented the number of observations included in the corresponding analysis.

Associations between selected variables were assessed using Spearman's rank correlation coefficients. The corresponding 95% confidence intervals for all reported correlations were calculated using percentile bootstrap confidence intervals based on 1,000 simple bootstrap samples. Correlation strength was interpreted as very weak (0.00–0.19), weak (0.20–0.39), moderate (0.40–0.59), strong

(0.60–0.79), or very strong (0.80–1.00). Effect sizes for group and paired comparisons were interpreted as small (r = 0.10–0.29), moderate (r = 0.30–0.49), and large ($r \geq$ 0.50). Subgroup analyses by sex and age were treated as exploratory. All statistical tests were two-sided, and statistical significance was set at $p < 0.05$.

Results

Participant flow

Participant flow and reasons for exclusion are presented in Table 1. Of the 183 adolescents who completed the pre-intervention questionnaire and the 163 who completed the post-intervention questionnaire, 122 paired questionnaires were successfully matched and included in the final analysis (Table 1).

Table 1. Participant flow and reasons for exclusion.

Stage	Pre-intervention	Post-intervention
Questionnaires completed during the study	183	163
Questionnaires not retained during identifier matching*	54	34
Unambiguously matched pre–post pairs after matching	**129 pairs**	**129 pairs**
Matched questionnaires excluded after application of eligibility criteria	7 pairs	
Paired questionnaires included in the final analysis	**122 pairs**	

*Note: Matching was based on participant-generated identification codes. Questionnaires not retained during this stage comprised records that could not be included in an unambiguous one-to-one pre–post match because of unmatched, duplicate, or triplicate identifiers.

General characteristics

The mean age of the study sample was 16.75 ± 0.95 years (mean ± SD; range 15–18 years; mode 17), and 51.6% (63/122) of participants were girls. Adolescents most often rated their health as very good (40%; 49/122) or good (45%; 55/122), while 12% (14/122) rated it as neither good nor bad and 3.0% (4/122) as bad.

Headaches (59.8%; 73/122) and nervousness (42.6%; 52/122) were the most frequently reported acute health complaints during the previous 6 months. The most commonly reported chronic conditions were allergies (26.2%; 32/122) and skin disorders (11.5%; 14/122).

During the same period, 52/122 (42.6%) of the adolescents reported using prescription medicines. Among participants reporting prescription medicine use, systemic antihistamines (ATC group R06) were the most frequently reported prescription medicine group, with desloratadine reported by 13/52 participants (25.0%) and representing the most frequently reported medicine within this group.

OTC medicine use was reported by 89.3% (109/122) of participants. Ibuprofen and paracetamol were the OTC medicines used most often by the participants, reported by 37.6% (41/109) and 27.5% (30/109) of adolescents, respectively. In addition, 60.0% (65/109) of respondents indicated OTC medicine use on more than two occasions during the monitored period.

Overall pre- and post-intervention comparisons

Overall pre- and post-intervention differences were examined in the full paired sample using the Wilcoxon signed-rank test. Higher self-reported knowledge ratings and changes in perceptions of prescription medicine safety were observed after the educational session. No statistically significant overall change was found in perceptions of OTC medicine safety. The corresponding results are presented in Table 2.

Table 2. Pre- and post-intervention comparison of self-reported knowledge about medicines and perceptions of medicine safety.

Outcome	Pre-intervention median (Q1–Q3)	Post-intervention median (Q1–Q3)	Z	p-value	Effect size (r)
Self-reported knowledge about medicines	3 (2–4)	2 (2–3)	−3.796	<0.001	r = 0.34
Perceived safety of prescription medicines	2 (2–3)	2 (1–2)	−4.191	<0.001	r = 0.38
Perceived safety of OTC medicines	2 (2–3)	2 (1–2)	−1.204	0.229	r = 0.11

Note. Pre- and post-intervention responses were compared using the Wilcoxon signed-rank test. All analyses presented in this table are based on 122 paired questionnaires. Lower scores indicate stronger agreement. Effect size is reported as $r = |Z| / \sqrt{N}$.

Perception of knowledge about medicines

Before the intervention, girls generally perceived themselves as being better informed about medicines than boys (median [Q1–Q3]: 2 [2–3] vs. 3 [2–4]), although this difference did not reach statistical significance (p = 0.071, r = 0.16; Table 3).

Comparison of pre- and post-intervention responses showed higher knowledge ratings after the educational session in both boys (Z = −3.252, p = 0.001, r = 0.42) and girls (Z = −2.190, p = 0.029, r = 0.28). In age-stratified analyses, knowledge ratings were higher following the educational session among 17-year-olds (Z = −2.511, p = 0.012, r = 0.34), whereas the remaining age groups showed smaller and inconsistent changes.

Perception of medicine safety

Before the educational intervention, boys and girls had comparable perceptions of prescription medicine safety (median [Q1–Q3]: 2 [1–3] vs. 2 [2–3], p = 0.207, r = 0.11; Table 3).

Perceptions of prescription medicine safety increased between the pre- and post-intervention assessments in both boys (Z = −2.003, p = 0.045, r = 0.26) and girls (Z = −3.853, $p < 0.001$, r = 0.49). In age-stratified analyses, statis-

Table 3. Self-reported knowledge about medicines and perceived safety of prescription medicines before the educational intervention.

	Would you overall say your knowledge about medicines is sufficient?							
	Strongly Disagree *N* [%]	Disagree *N* [%]	Neither Agree nor Disagree *N* [%]	Agree *N* [%]	Strongly Agree *N* [%]	Median (Q1–Q3)	*p*-value	Effect size (*r*)
Boys	5 [8.5]	16 [27.1]	13 [22.0]	21 [35.6]	4 [6.8]	3 (2–4)	$p = 0.071$	$r = 0.163$
Girls	0 [0]	12 [19.0]	16 [25.4]	32 [50.8]	3 [4.8]	2 (2–3)		
	Would you overall say prescription medicines are safe?							
	Strongly Disagree *N* [%]	Disagree *N* [%]	Neither Agree nor Disagree *N* [%]	Agree *N* [%]	Strongly Agree *N* [%]	Median (Q1–Q3)	*p*-value	Effect size (*r*)
Boys	2 [3.4]	2 [3.4]	13 [22.0]	27 [45.8]	15 [25.4]	2 (1–3)	$p = 0.207$	$r = 0.114$
Girls	1 [1.6]	5 [7.9]	19 [30.2]	26 [41.3]	12 [19.0]	2 (2–3)		

Abbreviations: N – number of adolescents. Note: Between-sex comparisons were performed using the Mann–Whitney *U* test. Lower Likert scores indicate stronger agreement. Effect size was calculated as $r = |Z|/\sqrt{N}$.

tically significant changes were observed among 15-year-olds ($Z = -2.714$, $p = 0.007$, $r = 0.66$) and 18-year-olds ($Z = -2.812$, $p = 0.005$, $r = 0.55$), whereas no statistically significant changes were found in the remaining age groups.

No statistically significant overall change was observed in perceptions of OTC medicine safety ($Z = -1.204$, $p = 0.229$, $r = 0.11$), and no consistent age-related pattern was found. However, a small but statistically significant pre- and post-intervention increase was observed among girls ($Z = -2.260$, $p = 0.024$, $r = 0.28$).

Parental supervision of adolescents' medication use

Most adolescents (66.4%; 81/122) reported discussing medicine use with their parents. Less than half of respondents (42.6%; 52/122) reported that they had never taken medicines without their parents' knowledge. Parents were more likely to supervise the use of prescription medicines (46.7%; 57/122) than OTC medicines (34.4%; 42/122). In 15.6% (19/122) of cases involving OTC medicine use, parents were unaware that the adolescent was taking the medicine.

No consistent age-related pattern in parental supervision was observed. The highest proportion of unsupervised OTC use was reported among 18-year-olds (23.1%), followed by 15-year-olds (17.6%; Table 4).

Associations between parental communication and medication-related variables are summarised in Tables 5 and Suppl. material 1. Among girls, communication with parents about medicines showed weak positive correlations with parental supervision of both prescription and OTC medicines. Among 18-year-olds, communication with parents was moderately associated with parental supervision of prescription medicines and moderately associated with perceived safety of prescription medicines before the intervention.

Discussion

The most consistent finding of this study was higher self-reported knowledge about medicines following the pharmacist-led educational session, with a moderate effect size observed in boys ($r = 0.42$) and a small effect size in girls ($r = 0.28$). This finding aligns with previous research showing that adolescents often report relatively high confidence in their knowledge despite gaps in their understanding of safe medicine use and practical aspects of pharmacotherapy (Hämeen-Anttila and Bush 2008; Dawood et al. 2014; Shehnaz et al. 2014; Klimaszova et al. 2018a; Ma and Zhang 2025). At the same time, perceived knowledge does not necessarily correspond to actual un-

Table 4. Age-related trends in parental oversight of prescription and OTC medicines.

Medications	**Rx**				**OTC**			
Age [years]	**15 (*n* = 17) [%]**	**16 (*n* = 23) [%]**	**17 (*n* = 56) [%]**	**18 (*n* = 26) [%]**	**15 (*n* = 17) [%]**	**16 (*n* = 23) [%]**	**17 (*n* = 56) [%]**	**18 (*n* = 26) [%]**
Parents know and supervise	52.9	43.5	44.6	50	47.1	34.8	37.5	19.2
Parents know but do not supervise	47.1	56.5	51.8	50	35.3	56.5	48.2	57.7
Parents do not know and do not supervise	0	0	3.6	0	17.6	8.7	14.3	23.1

Abbreviations: Rx – prescription medicines; OTC – over-the-counter medicines.

Table 5. Spearman correlations between parental communication and medication-related variables.

Variables analysed	**Subgroup**	***n***	**Spearman's *ρ***	**95% CI**	***p*-value**
Parental communication vs. supervision of prescription medicines	Girls	63	0.341	0.089–0.553	0.006
Parental communication vs. supervision of OTC medicines	Girls	63	0.284	0.093–0.483	0.024
Parental communication vs. supervision of prescription medicines	18 years	26	0.489	0.155–0.770	0.011
Parental communication vs. perceived safety of prescription medicines before the intervention	18 years	26	0.417	0.035–0.676	0.034

Abbreviations: OTC – over-the-counter medicines; CI – confidence interval. The 95% confidence intervals were estimated using percentile bootstrap intervals based on 1,000 bootstrap samples.

Note: Only statistically significant correlations discussed in the Results section are presented. All p-values are two-sided. Additional exploratory subgroup analyses are presented in Suppl. material 1.

derstanding, and the observed change should therefore be interpreted with caution.

These findings were also reflected in the overall pre- and post-intervention comparison, which showed statistically significant changes in self-reported knowledge about medicines and perceptions of prescription medicine safety, while no significant overall change was observed for perceptions of OTC medicine safety.

Perceived safety of prescription medicines increased following the educational session in both sexes, with a larger effect size among girls (r = 0.49) than boys (r = 0.26). In contrast, no significant overall change was observed in perceived safety of OTC medicines (r = 0.11), although a small increase was observed among girls (r = 0.28). One possible explanation is that the educational session presented medicine safety in the context of appropriate use. It introduced quality, efficacy, and safety as fundamental properties of medicines and explained medicine development and clinical testing, while also addressing dose-related risks, adverse effects, interactions, and misuse. Thus, the observed increase in perceived safety may reflect a better understanding that medicines can be used safely when used appropriately, rather than a perception that medicines are without risk. This pattern is consistent with findings suggesting that adolescents tend to perceive OTC medicines as familiar and relatively safe, which may reduce their sensitivity to educational messages (Shehnaz et al. 2014; Abraham and Chmielinski 2018; Liu et al. 2024). From a clinical pharmacy perspective, this highlights a need for more targeted communication addressing specific misconceptions related to commonly used non-prescription medicines.

Age-specific analyses did not show a consistent pattern. While significant changes were observed in some subgroups (e.g. r = 0.34 among 17-year-olds; r = 0.66 among 15-year-olds and r = 0.55 among 18-year-olds), these effects were not consistent across all age groups and should be interpreted cautiously given the smaller subgroup sizes. Similar variability has been reported in school-based health literacy interventions, where effectiveness depends on the design, duration, and contextual factors of the intervention (Smith et al. 2021; Khanal et al. 2025). These findings suggest that adolescents may respond differently to short interventions and that age-adapted approaches may improve outcomes.

The pattern of medicine use reported in this study is in line with previously published data (Shehnaz et al. 2014). Ibuprofen and paracetamol were the most commonly reported OTC medicines, accounting for 37.6% and 27.5% of OTC medicine users, respectively. Similar trends have been reported in large population-based studies, where over-the-counter analgesics such as paracetamol and ibuprofen are among the most frequently used medicines in adolescents, particularly for headaches and other common pain conditions (Jonassen et al. 2021; Roalsø et al. 2024). The high use of pain-relieving medicines is often linked to common complaints such as headaches, which are widely reported among adolescents and are a leading reason for OTC medicine use. Systematic reviews and epidemiological studies have consistently identified analgesics as the most commonly used medicines in adolescent self-medication (Shehnaz et al. 2014; de Sanctis et al. 2020; Kiza et al. 2021). This suggests that future educational interventions may benefit from focusing more explicitly on commonly used analgesics. At the same time, the frequent use of these medicines raises concerns about inappropriate self-medication, including incorrect dosing and underestimation of potential adverse effects. Previous research indicates that even commonly used and familiar OTC medicines may be associated with unsafe use patterns and insufficient awareness of risks among adolescents (Abraham and Chmielinski 2018; Jonassen et al. 2021). From a clinical pharmacy perspective, this supports focusing educational efforts on frequently used medicines encountered in everyday practice.

Parental involvement showed only modest associations with adolescents' medicine-related behaviours. Most participants reported discussing medicines with their parents (66.4%), yet 15.6% reported using OTC medicines without parental awareness. Weak correlations between communication and supervision (e.g. ρ = 0.341 for prescription medicines and ρ = 0.284 for OTC medicines among girls) indicate that communication may play a role but is not sufficient on its own. This is in line with previous studies suggesting that family context influences adolescent self-medication but does not fully prevent inappropriate use (Levin et al. 2015; Lee et al. 2017; Kalaman et al. 2023). From a practice perspective, this highlights the importance of involving both adolescents and their caregivers in educational interventions.

Overall, the pharmacist-led educational session was followed by changes in adolescents' medication-related knowledge and selected safety perceptions, particularly in relation to prescription medicines. Higher self-reported confidence in medicine-related knowledge was observed after the session in both boys and girls. In contrast, changes in safety perceptions were less evident. The strongest effect was observed for prescription medicines, particularly among girls, whereas perceptions of OTC medicines showed only minimal change. These findings suggest that a single educational session may be followed by short-term changes in self-reported knowledge, whereas established perceptions of medicine safety may be less responsive. They also support the potential value of pharmacist involvement in adolescent health education within both school and community settings (Abraham and Chmielinski 2018).

Limitations of this study

The results should be interpreted in the context of several study limitations. Because no control group was included, it is not possible to clearly distinguish the effect of the intervention from other factors that may have influenced participants during the study period. The analyses were restricted to adolescents who completed both question-

naires, while no data were available for those who did not participate in the follow-up survey. Responses were based on self-assessment rather than objective testing and may therefore not fully reflect actual knowledge. Furthermore, the adapted questionnaire was used without additional validation in the study population. As participants were recruited from schools in a single urban area, the extent to which these findings apply to adolescents in other settings remains uncertain. The sex- and age-stratified analyses were exploratory and involved multiple comparisons; therefore, isolated statistically significant subgroup findings should be interpreted cautiously.

Furthermore, the post-intervention questionnaire was completed immediately after the educational session; therefore, the findings reflect only short-term changes and do not indicate whether these changes were sustained over time.

Conclusion

The educational session was followed by higher self-reported medicine-related knowledge in both boys and girls. In contrast, attitudes towards medicine safety changed only modestly, with the most noticeable differences observed for prescription medicines. Perceptions of OTC medicines were relatively stable despite their frequent use.

One finding that deserves consideration is that a proportion of participants reported using OTC medicines without their parents' knowledge. Together with the high frequency of OTC medicine use observed in the sample, this suggests that adolescents often make decisions about medicine use with limited adult involvement.

The study provides an initial view of how adolescents respond to pharmacist-led education on medicines. Further work is needed to establish whether the changes observed shortly after the intervention are maintained over time.

Acknowledgements

The authors express their gratitude to the participating schools, including their directors and class teachers, for their cooperation in data collection, and to all respondents for completing the questionnaires.

References

Abraham O, Chmielinski J (2018) Adolescents' misuse of over-the-counter medications: The need for pharmacist-led intervention. Innovations in Pharmacy 9: 1–7. https://doi.org/10.24926/iip.v9i3.979

Almunef M, Mason J, Curtis C, Jalal Z (2019) Young people and the management of chronic illness by primary care pharmacists: A systematic review. Pharmacy 7: 1–89. https://doi.org/10.3390/pharmacy7030089

Aston J, Wilson KA, Terry DRP (2019) The treatment-related experiences of parents, children and young people with regular prescribed medication. International Journal of Clinical Pharmacy 41: 113–121. https://doi.org/10.1007/s11096-018-0756-z

Bakaruddin S, Mohd Noordin Z, Karuppannan M (2022) Affecting children's knowledge about rational use of medicines using read-along videos of pictorial storybooks. Frontiers in Pharmacology 13. https://www.frontiersin.org/articles/10.3389/fphar.2022.933546 [April 5, 2023]

Boztepe H, Özdemir H, Karababa Ç, Yıldız Ö (2016) Administration of oral medication by parents at home. Journal of Clinical Nursing 25: 3345–3353. https://doi.org/10.1111/jocn.13460

Dawood OT, Ibrahim MIM, Abdullah AC (2014) Familiarisation of Children with Medicines and their Sources of Information. Journal of Clinical and Diagnostic Research: JCDR 8: 329–330. https://doi.org/10.7860/JCDR/2014/6902.3898

Dawood OT, Mohamed Ibrahim MI, Abdullah AC (2015) Children's knowledge and beliefs about medicines. Journal of Child Health Care 19: 73–83. https://doi.org/10.1177/1367493513496911

de Sanctis V, Soliman AT, Daar S, Di Maio S, Elalaily R, Fiscina B, Kattamis C (2020) Prevalence, attitude and practice of self-medication among adolescents and the paradigm of dysmenorrhea self-care management in different countries. Acta Bio Medica: Atenei Parmensis 91: 182–192. https://doi.org/10.23750/abm.v91i1.9242

Hämeen-Anttila K, Bush PJ (2008) Healthy children's perceptions of medicines: A review. Research in Social and Administrative Pharmacy 4: 98–114. https://doi.org/10.1016/j.sapharm.2007.05.002

Hämeen-Anttila K, Juvonen M, Ahonen R, Bush PJ, Airaksinen M (2006) How well can children understand medicine related topics? Patient Education and Counseling 60: 171–178. https://doi.org/10.1016/j.pec.2004.12.011

Herzig M, Bertsche A, Kiess W, Bertsche T, Neininger MP (2022) Medicine and supplement use in infants, children, and adolescents depends on sex, age, and socioeconomic status: results of a German longitudinal population-based cohort study (LIFE Child). European Journal of Pediatrics 181: 2991–3003. https://doi.org/10.1007/s00431-022-04504-w

Horák O (2022) Jedia veľa liekov, dusia sa, vdychujú škoricu. Prečo deti plnia rizikové výzvy na internete a ako ich chrániť? Denník N. https://dennikn.sk/2961326/jedia-vela-liekov-dusia-sa-vdychuju-skoricu-preco-deti-plnia-rizikove-vyzvy-na-internete-a-ako-ich-chranit/ [February 19, 2024]

Jonassen R, Hilland E, Harmer CJ, Abebe DS, Bergem AK, Skarstein S (2021) Over-the-counter analgesics use is associated with pain and psychological distress among adolescents: a mixed effects approach in cross-sectional survey data from Norway. BMC Public Health 21: e2030. https://doi.org/10.1186/s12889-021-12054-3

Kalaman CR, Ibrahim N, Shaker V, Cham CQ, Ho MC, Visvalingam U, Shahabuddin FA, Abd Rahman FN, A Halim MRT, Kaur M, Azhar FL, Yahya AN, Sham R, Siau CS, Lee KW (2023) Parental factors associated with child or adolescent medication adherence: A systematic review. Healthcare 11: e501. https://doi.org/10.3390/healthcare11040501

Kelly T, Conn KM, Zak M (2018) Evaluation of over-the-counter medication knowledge and literacy in adolescent students. Academic Pediatrics 18: 556–562. https://doi.org/10.1016/j.acap.2018.02.012

Khanal SP, Budhathoki CB, Okan O (2025) Effectiveness of a school-based health literacy intervention in improving adolescent health literacy and the intention to take health-promoting actions. BMC Public Health 25: e3551. https://doi.org/10.1186/s12889-025-24827-1

Kiza AH, Manworren RCB, Cong X, Starkweather A, Kelley PW (2021) Over-the-counter analgesics: a meta-synthesis of pain self-management in adolescents. Pain Management Nursing 22: 439–445. https://doi.org/10.1016/j.pmn.2021.04.010

Klimaszova Z, Fazekas T, Kuzelova M (2018a) Adolescents' knowledge and perception of medicine risk. Pediatrics International: Official Journal of the Japan Pediatric Society 60: 735–742. https://doi.org/10.1111/ped.13609

Klimaszova Z, Fazekas T, Kuzelova M (2018b) Relationship between adolescents' and their parents' attitudes toward medicines and awareness of the risk of medicines. International Journal of Clinical Pharmacy 40: 1501–1510. https://doi.org/10.1007/s11096-018-0723-8

Lee C-H, Chang F-C, Hsu S-D, Chi H-Y, Huang L-J, Yeh M-K (2017) Inappropriate self-medication among adolescents and its association with lower medication literacy and substance use. PLOS ONE 12: e0189199. https://doi.org/10.1371/journal.pone.0189199

Levin KA, Whitehead R, Andersen A, Levin D, Gobina I, Holstein B (2015) Changes in the association between health complaint frequency and medicine use among adolescents in Scotland between 1998 and 2010. Journal of Psychosomatic Research 78: 371–376. https://doi.org/10.1016/j.jpsychores.2014.12.006

Liu D, Ge P, Li X, Hong W, Huang M, Zhu L, Kaierdebieke A, Yu W, Qi J, Pu K, Ling R, Pan L, Sun X, Wu Y, Feng Q (2024) Status of self-medication and the relevant factors regarding drug efficacy and safety as important considerations among adolescents aged 12–18 in China: A cross-sectional study. Scientific Reports 14: e9982. https://doi.org/10.1038/s41598-024-59204-2

Ma C, Zhang H (2025) A cross-sectional study on self-medication with over-the-counter drugs among adolescents: an analysis of current practices. Frontiers in Public Health 13. https://doi.org/10.3389/fpubh.2025.1560299

Melo MTB de, Santana GB de A, Rocha MHA, Lima RK de S, Silva TAB da, Souza CDF de, Rodrigues AKBF (2022) Epidemiological profile and temporal trend of exogenous intoxications in children and adolescents. Revista Paulista de Pediatria 40: e2021004. https://doi.org/10.1590/1984-0462/2022/40/2021004in

Murdock J (2020) Highlighting the dangers of the 'Benadryl Challenge' - pharmacist consult. https://www.pharmacistconsult.com/highlighting-the-dangers-of-the-benadryl-challenge/ [February 19, 2024]

Recchiuti K, Malone MK, Zimmerman B (2018) School program improves adolescents' knowledge of responsible medicine use. Health Behavior and Policy Review 5: 98–115. https://doi.org/10.14485/HBPR.5.6.9

Roalsø ES, Klonteig S, Kraft B, Skarstein S, Aalberg M, Jonassen R (2024) Associations between over-the-counter analgesics usage and symptoms of anxiety and depression in adolescents: a network analysis. BMC Psychiatry 24: e366. https://doi.org/10.1186/s12888-024-05802-3

Sakai C, Iguchi K, Tachi T, Noguchi Y, Katsuno S, Teramachi H (2019) Factors influencing medicine use behavior in adolescents in Japan using a bayesian network analysis. Frontiers in Pharmacology 10: e494. https://doi.org/10.3389/fphar.2019.00494

Schaeffer D, Gille S, Vogt D, Hurrelmann K (2023) National action plan health literacy in Germany origin, development and structure. Journal of Public Health 31: 905–915. https://doi.org/10.1007/s10389-021-01616-9

Shehnaz SI, Agarwal AK, Khan N (2014) A systematic review of self-medication practices among adolescents. Journal of Adolescent Health 55: 467–483. https://doi.org/10.1016/j.jadohealth.2014.07.001

Siitonen P, Hämeen-Anttila K, Keinonen T, Vainio K (2014) Medicine education as a part of health education: The implementation in Finnish comprehensive schools. International Journal of Health Promotion and Education 52: 90–104. https://doi.org/10.1080/14635240.2013.871409

Smith C, Goss HR, Issartel J, Belton S (2021) Health literacy in schools? A systematic review of health-related interventions aimed at disadvantaged adolescents. Children 8: e176. https://doi.org/10.3390/children8030176

Syofan S, Dachriyanus D, Masrul M, Rosfita R (2023) The knowledge and attitudes about the benefits, risks and use of medicine in aged primary students in Indonesia. Open Access Macedonian Journal of Medical Sciences (OAMJMS) 7: 1860–1866.

Additional information

Conflict of interest

J. Urbankova and S. Kosirova declare that they have no conflicts of interest.

Ethical statements

The authors declared that no clinical trials were used in the present study.

The study was conducted in accordance with the principles of the Declaration of Helsinki. Under the framework of Slovak Act No. 576/2004 Coll., applicable at the time of data collection, the study was not considered to require prior ethics committee approval; therefore, no ethics approval number was issued.

Data collection was conducted online during distance education amid the COVID-19 pandemic. Permission to conduct the study was obtained from the directors of all participating schools. Parents or legal guardians were informed about the study through the participating schools before data collection and were given the opportunity to decline their child's participation.

Participation was voluntary, and adolescents provided electronic informed consent before completing the questionnaires. No directly identifying personal information was collected, and participants generated their own identification codes for matching the pre- and post-intervention questionnaires.

The authors declared that no commercially available immortalised human and animal cell lines were used in the present study.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
During manuscript preparation, AI-assisted tools (MS Copilot) were used only for language editing and stylistic refinement. No AI tools were used for data analysis, data interpretation, or generation of results. All scientific content was reviewed and approved by the authors.

Funding

This work was supported by a grant from the Faculty of Pharmacy, Comenius University Bratislava [grant number FaF/18/2024], grants from the Slovak Pharmaceutical Chamber [grant numbers SLeK/19/2024 and SLeK/08/2025], and a grant from the Ministry of Education, Research, Development and Youth of the Slovak Republic [grant number KEGA 089UK-4/2025].

Author contributions

All authors contributed to the conception and design of the study. JU collected and prepared the data for analysis. SK performed the statistical analyses, interpreted the findings, and wrote the original draft of the manuscript. All authors revised the manuscript and commented on previous versions. All authors have read and approved the final manuscript.

Author ORCIDs

J. Urbankova https://orcid.org/0009-0000-6667-6917
S. Kosirova https://orcid.org/0000-0001-7174-1939

Data availability

The data supporting the findings of this study are available from the corresponding author (S.K.) upon reasonable request.

Supplementary material 1

Spearman rank correlations between parental communication and medication-related variables by sex and age

Authors: Jana Urbankova, Stanislava Kosirova
Data type: docx
Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.
Link: https://doi.org/10.3897/pharmacia.73.e204525.suppl1