Long-term impact of a community pharmacist-led theme day on medication knowledge for primary school students: a questionnaire survey

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Abstract

Background: The autonomy of children in medication use has increased globally, with many children using medicines without parental awareness. Children's knowledge about medication, however, is often inadequate. With education on medication limited in elementary schools in many countries, including in Denmark, community pharmacists may play a crucial role in enhancing medication knowledge among children. In the national Danish project School Medicines Theme Day (SMT intervention), community pharmacists, in cooperation with teachers, spent a full day teaching primary school students (4th to 6th grade) about safe medication use through hands-on activities.

Objective: The aim of this study was to investigate primary school students' long-term knowledge about medication and handling of medication before and 1–2 months after the SMT intervention. We hypothesized that increased knowledge would lead to safer and more appropriate medication handling by the students.

Methods: A survey (comprising 12 items) was distributed to the 81 primary school classes participating in the SMT intervention between 2023 and 2024, with a pre-intervention (Survey 1) and a post-intervention survey (Survey 2). Data analysis was conducted at class level by the use of a nonparametric Wilcoxon signed rank test to evaluate changes in students' responses, with a significance level set at 5%.

Results: The response rates were 100% for Survey 1 (1,394 students) and 88% for Survey 2 (949 students). Significant improvements in students' knowledge about medication and its handling were observed for 9 out of 12 items, indicating a lasting effect of the SMT intervention. No significant change was noted for the 2 items related to scientific concepts in the Danish curriculum.

Conclusion: The SMT intervention led by community pharmacists significantly improved primary school students' knowledge about medication months after the intervention. A broader implementation of such activities could enhance long-term medication literacy and safe handling practices among students.

Keywords: medication, primary school students, knowledge, community pharmacists, intervention, survey

Description of the Problem

Globally, children have recently gained greater autonomy in their use of medicine. They use medications such as over-the-counter analgesics more frequently and, at middle-school age, are often allowed to use this type of medication without their parents' awareness.[1,2] Many children also have inadequate knowledge and false beliefs about the efficacy of medicines; they may, for example, believe that the size, taste, or color of a pill is related to how well a medication works.[1,3–5]

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While it is therefore important to educate children about medicines from an early age, only a few elementary school education programs worldwide provide dedicated classes on medicine and the handling of medicine. The Danish national curriculum does not have specific goals related to these topics, but does include goals related to health, including helping students understand the human circulatory system and providing dietary guidance. Additionally, the "Health and Sex Education and Family Studies" curriculum emphasizes the use of partnerships between schools and local enterprises to develop students' ability to critically evaluate information and take action to promote their own and others' health.[6]

Given that they frequently interact with prescribers, school personnel, parents, and accompanying children while working in a pharmacy, community pharmacists may play a crucial role in enhancing knowledge about medication among students. There is only limited research, however, on the role of pharmacists in teaching primary or secondary school students about medication.[7] A medicine education program for elementary and middle school students was developed in

Finland, with school teachers educated about the appropriate use of medicines through teaching materials created by pharmacists.[8] However, the teachers faced difficulties in handling the wide range of student questions because of their lack of familiarity with the topic. In the U.S., student pharmacists led an elementary school health education program focusing on topics such as nutrition, medication safety, and tobacco prevention.[9] Pre- and post-intervention surveys showed significant improvements in knowledge among elementary school students with respect to medication safety and tobacco prevention.[9] Other U.S. studies reported that student pharmacists considered a program on over-the-counter medication safety for school children useful and effective and that the program increased children's knowledge about medications[10,11] In Taiwan, local pharmacists educated students from primary and middle schools about correct medication use, and pre- and post-intervention questionnaires showed a significant increase in children's knowledge, self-efficacy, and skills in appropriate medication use.[12,13] And in Ecuador, medical students trained secondary school students in rational medication use during one school day and reported a significant increase in knowledge, both short-term and long-term.[14] Furthermore, a scoping review revealed that educational programs about medication use increased students' knowledge, medication literacy, and confidence. The success of these programs, however, is dependent on the educator's comfort level and knowledge about medication.[15]

The aim of this study was to investigate primary school students' (aged 10–13 years) long-term knowledge about medication and handling of medication before and 1–2 months after a community pharmacist–led theme day. We hypothesized that a change in medication knowledge may also lead to a change in medication handling — i.e., increased knowledge about medication will result in safer and more appropriate handling of medication among primary school students.

Methods

School Medicine Theme Day concept (the intervention)

From 2011 to 2018, approximately 100 Danish schools were involved in a project entitled The School Medicine Project (SMP), where, for 2–3 hours, pharmacy students taught more than 1,500 4th to 6th grade students (10–13 years old) about the use of medicines.[16,17] The School Medicine Theme day (SMT) is an extension of the SMP. From 2017–2019 (with a one year overlap with the SMP), an interdisciplinary group including pharmacists (researchers and community pharmacists), physicians specializing in pediatric pharmacology and pediatric anesthesia and pain, and an educational specialist developed and pilot tested the SMT day concept. One of the team pharmacists also taught at several SMT-days during the project period. In the current implementation of the SMT day (2022–2024) the core project group consisted of researchers, clinical pharmacists, and a schoolteacher closely collaborating with specialists in pediatric pain and natural sciences education in primary schools.

SMT day activities lasted the entire school day, with local community pharmacists teaching at a nearby school. The activities, which had a particular focus on over-the-counter analgesics commonly used for mild pain such as headache, included hands-on exercises that were specifically developed for the age group and that integrated play and learning. The day's primary learning objective was that the primary school students gained knowledge about the safe use and handling of medication.

Community pharmacists and schools signed up for free participation in the SMT intervention, and the project working group matched each school with a local pharmacy. When the date of a planned SMT day was set, the teaching material was sent to the schoolteacher (teaching guides for each educational activity) and the pharmacist (a box with teaching guides and all materials needed for the SMT day). The schoolteachers also received a template for an information letter to send to the parents.

The SMT intervention included three parts (Figure 1):

1. Activities conducted by the class teacher 1–2 weeks prior to the theme day (including the preintervention survey)
2. Eight hands-on activities aimed at imparting knowledge on safe medication use and handling, conducted by the community pharmacist on the theme day.
3. Postintervention survey (after 1–2 months)

The population chosen for the SMT educational activity was 4th to 6th grade students. Both pharmaceutical researchers and educational consultants supported the decision of prioritizing primary school students over older students, highlighting the unique potential of students in these intermediate years. Experts and teachers emphasize the late primary school years as a period where students possess more cognitive maturity as well as motivation for school activities, making them particularly well suited to immersive and engaging in learning experiences compared to the early secondary school years, during which motivation tends to decrease.[18] One reason for this decrease is that secondary school students frequently face excessive pressure from curriculum demands and high-stakes assessments, leading to stress and diminished academic motivation.[19] These stressors also affect teachers, who are more inclined to focus on covering the curriculum in lower secondary school and therefore tend to be less inclined to engage in topics such as health and medicine that are outside the national curriculum.

Questionnaire survey: Primary school students' knowledge of medication

A questionnaire survey was developed by natural sciences educational specialists in collaboration with the core project group; this was distributed to the school classes participating in the SMT day approximately one week before and approximately 2 months after the theme day. The questionnaire was specifically designed to evaluate the knowledge students gained from participating in the SMT day. No previous surveys could be found that fit the specific needs for this evaluation, which was strongly linked to the activities of the SMT day. Consequently, the survey was designed from scratch, taking into account the following design considerations: age-appropriate language and content were applied, utilizing simple, everyday vocabulary and clear question structures to minimize confusion; the students' cognitive development and literacy levels were considered; and the survey was limited to as few items as meaningfully possible to prevent response fatigue.

The survey was designed to evaluate two key dimensions: (A) students' competency in handling and using medication, and (B) students' knowledge of scientific topics related to the human body. The survey consisted of 16 items in total, including four background questions (name of school, class/grade, gender, and whether the students remembered any teaching about medication prior to the SMT day).

Questionnaire part A: Competency in handling and using medication (10 items)

This section was grounded in the concept of action competence,[20] interpreted as the students' ability to apply their knowledge and skills in everyday situations related to the handling and use of medication, particularly over-the-counter painkillers. Each of the survey questions in this section was linked to specific learning objectives related to the eight exercises included in the SMT intervention. These objectives included the students' abilities to identify different forms of medications (e.g., tablets, capsules, nasal sprays, eye drops), to understand the consequences of appropriate versus inappropriate medication use, to recognize correct medication storage practices, to distinguish between different medication dissolution and absorption techniques (e.g., dispersible tablets vs. standard tablets), and to evaluate the beneficial or harmful use of medication in common situations they may experience in their everyday life. Additionally, the students' ability to extract and utilize information from medication packaging and leaflets was assessed to determine whether they could identify reliable sources of medication-related information. Finally, the students were expected to understand that the experience of pain is context related and to recognize nonpharmacological methods for pain management, such as distraction techniques.

Questionnaire part B: Scientific knowledge (2 items)

This section of the survey was designed to measure students' understanding of key scientific concepts found in the Danish national curriculum as taught in grades 4 to 6.[6] Survey questions were constructed to address curriculum goals such as having knowledge of health related to one's everyday life, the causes of healthy and unhealthy lifestyles, and basic health-promoting factors. Part B consisted of 2 items.

Pilot testing of questionnaire

The content validity of each item was ensured through an iterative process involving the project group experts with interprofessional expertise and three experts within education, sociology and teaching who evaluated the alignment of the survey items with the knowledge dimensions. The experts assessed whether the questions accurately reflected the constructs being measured and provided feedback on any gaps or redundancies.[21] This stage also included discussions with science teachers and subject matter experts to ensure content validity. The draft survey was then subjected to pilot testing with two classes of students of the target age (approximately 50 students). The pilot testing aimed to identify potential issues with question clarity, item difficulty, and the overall length of the survey. In addition, an experienced teacher responsible for one of the pilot test classes commented on the draft survey. After the pilot data were analyzed, several items were revised to reduce ambiguity and align the items more closely with the targeted knowledge dimensions, and one item was removed from section B (which decreased to two items) since one of the questions was generally not understood by the students.

Data handling and analysis

No formal sample size analysis was performed, but the recruitment of 80 school classes was planned for the evaluation of SMT intervention. Prior to carrying out the statistical tests, the pre- and post-survey datasets were cleaned to remove errors such as incorrect inputs, duplicate entries, and inconsistencies introduced during survey administration. Each item in the survey was scored based on the number of correct and incorrect answers, which varied from 3 to 7 possible correct answers for each question. For comparison of the students' answers from Survey 1 with those from Survey 2, the answers were first indexed by creating a calculated variable for each survey item, where the respondents' answers yielded an item score, depending on whether they answered correctly or incorrectly. If a student answered correctly, a score of 1 was given. If a student had not ticked any incorrect answers, a score of 1 was also given. If a student had answered incorrectly, i.e., ticked a wrong answer or did not tick a correct answer, a score of -1 was given. Each student therefore received a total score for each item based on the number of correct or incorrect answers to each question. As a result, some survey items could yield negative values.

The following null hypothesis and alternative hypothesis were developed:

H0: There is no significant difference in the students' answers.

HA: There is a significant difference in the students' answers.

Owing to the nonlinear distribution of the students' responses, a nonparametric pairwise Wilcoxon signed rank test, with Holm's correction of the p-values, was conducted. This test was performed to analyze whether there was a significant change in the students' responses to Survey 1 (pre-intervention) and Survey 2 (post-intervention). The significance level was set at 5%.

Results

The survey was distributed to the 81 school classes that participated in the SMT intervention. All 81 school classes responded to Survey 1 (pre-intervention survey). The second survey (post-intervention survey) was also distributed to all the participating school classes, and 71 classes responded, a response rate of 88%. A total of 1,394 students from the 81 classes replied to the pre-intervention survey, and 949 students replied to the post-intervention survey.

Fifteen percent of the students who participated in Survey 1 had participated in educational activities about medicine at their school prior to the SMT day.

Table 1 lists each survey item, the population median, mean, and standard deviation, and the corresponding p value. Owing to the design of the survey and protection of personal data, it was not possible to track individual student responses across the two surveys; the calculation of the p values was thus carried out at the population level.

Survey Item	P value	Mean, Median, and Standard Deviation (SD) for the Indexed Score Results - Survey 1	Mean, Median, and Standard Deviation (SD) from the Indexed Score Results - Survey 2
1. What do you think: Which of these are medicines?	P < 0.0001	Mean=3.86 Median=3 SD=2.06	Mean=4.87 Median=5 SD=2.40
2. What do you think: Why is it sometimes smarter to take a dissolvable tablet rather than a regular tablet?	P < 0.0001	Mean=0.12 Median=1 SD=1.24	Mean=0.56 Median=1 SD=1.60
3. What do you think: Where in the house should you preferably store medicine?	P < 0.0001	Mean=1.50 Median= 2 SD=2.12	Mean=2.02 Median=2 SD=1.51
4. What do you think: What are side effects (which answer is most correct)?	P < 0.0001	Mean=0.13 Median= 1 SD=1.45	Mean=0.49 Median=1 SD=1.07
5. What do you think: Which factors can prevent medicine from working effectively?	P < 0.0001	Mean= -1.86 Median= -2 SD=1.36	Mean= -1.12 Median= -2 SD=1.84
6. What do you think: What can one do to ensure medicine has the best effect?	P= 0.079	Mean=1.25 Median=1 SD=1.91	Mean=1.49 Median=1 SD=1.58
7. What do you think: What should you read on a package insert?	P < 0.0001	Mean=2.78 Median=3 SD=2.68	Mean=3.25 Median=5 SD=2.51
8. What do you think: What can be smart to do if you have a headache?	P < 0.0001	Mean=1.50 Median=1 SD=2.00	Mean=2.43 Median=3 SD=2.11
9. What do you think: Which of these statements are correct?	P= 0.008	Mean = 0.94 Median = 2 SD = 2.00	Mean = 1.20, Median = 2, SD = 1.75
10. What do you think: Where can you easily find reliable information about medicine?	P < 0.0001	Mean = 4.03 Median = 5 SD = 1.61	Mean = 4.62 Median = 5 SD = 2.57

Survey Item	P value	Mean, Median, and Standard Deviation (SD) for the Indexed Score Results - Survey 1	Mean, Median, and Standard Deviation (SD) from the Indexed Score Results - Survey 2
11. What do you think: How do medication tablets find their way to the intended target in the body? **	P=0.079	Mean = 1.88 Median = 2 SD = 1.85	Mean = 1.90 Median = 2 SD = 1.75
12. What do you think: Why can the same kind of pill relieve growing pain in the legs one day and pain in the ear the next day? **	P= 0.597	Mean = 1.25 Median = 1 SD = 1.77	Mean = 1.76 Median = 2 SD = 1.72

**Survey item no. 11 and 12 were included in order to measure students' understanding of key scientific concepts found in the Danish national curriculum as taught in grades 4 to 6

Based on this analysis, we rejected the null hypothesis (H0) for all the items concerning students' knowledge about medicine and how to handle medicine (Items 1–10, Table 1), which assumed that there was no difference in the students' knowledge between the two surveys. Instead, we accepted the alternative hypothesis (HA), which asserted that there was a significant difference in students' knowledge about medicine and appropriate handling of medicine after the intervention. For 9 out of 10 items, the calculated p values were below the significance level of 0.05, indicating that the students gained and retained new knowledge after the SMT intervention.

For the two items (Items 11–12, Table 1) targeting the students' understanding of scientific concepts found in the Danish national curriculum, the null hypothesis could not be rejected, as there was no significant change in the students' answers, even though there was a difference.

The positive results indicated significant and lasting knowledge gain from this one-day intervention, which potentially may lead to increased action competence among the students.

Discussion

In this study, we showed that it was possible to considerably increase primary school students' knowledge about medicine and medication handling through the SMT intervention. We observed statistically significant increases in students' responses to the survey questions about medicine and how to handle it 1–2 months after the SMT educational intervention. This indicated lasting increases in knowledge. The two survey items related to scientific concepts did not, however, indicate significant learning. The reason for this could be that the intervention included less emphasis on teaching students science.

The results of this study suggest that teaching students about medicine in primary school is both relevant and beneficial. Other authors have also found teaching about medicines useful, and shown that the children's knowledge about medications was increased following the teaching.[10–13] This is also supported by a survey among experts showing that out of 499 U.S. pharmacy faculty members, 432 (86.6%) believed that the issue of medication management in schools was either somewhat or extremely important.[7] A broader implementation of such activities could enhance long-term medication literacy and safe handling practices among students.

This study is also an excellent example of community engagement. The fact that community pharmacists from local pharmacies contributed to increased knowledge about medicine and, presumably, to more appropriate medication behavior among primary school students (who are the medication users of the future) shows that the SMT intervention has a strong impact on the communities served. We agree with the conclusion of Hämeen-Anttilla and Bush[1] that health educators and health care professionals should educate children about rational medicine use at appropriate cognitive development levels before children become independent medicine users. On a more general level, community pharmacists in Denmark can and to some degree already incorporate community engagement into their practice in several meaningful and impactful ways. Some examples are health promotional and educational activities (hosting workshops or seminars on topics like medication safety, chronic disease management, smoking cessation, or healthy living, and participating in local health fairs and school events to provide information and screenings); collaboration with local organizations (partnering with schools, senior centers, or community centers, and working with non-profits or public health departments on campaigns); offering patient-centered services (doing medication reviews and providing multilingual support or culturally sensitive care to reflect the community's diversity); encouraging community feedback/involvement (through feedback channels and involving community members — e.g., local schools — in planning services or events to ensure relevance and inclusivity); doing outreach activities (providing home delivery or mobile pharmacy services for underserved or remote populations and extending hours or offering telepharmacy consultations to increase accessibility), and actively using social media (posting on platforms like Facebook or Instagram to share health tips, announce events,

or engage in Q&A sessions, and creating newsletters and blogs with updates and educational content).

Strengths and limitations

This study had several limitations. First, because the study design did not allow us to track changes in knowledge for individual students, we could only analyze changes in knowledge at the population level. Second, the survey items were not developed using a consistent item framework. For example, some items had four answer categories with three correct answers, while others had seven answer categories and only two correct answers. These inconsistencies complicated comparisons across groups and prevented internal consistency testing. Third, data analyses revealed a high degree of variability in responses, as standard deviations were often greater than or nearly equal to the mean values. This suggests significant variation within the dataset, which indicates that the students' answers reflect different levels of knowledge — some understood the subject well, while others did not understand it as well. This may be related to differences in the students' age. In some cases, the median values were closely aligned with the mean values, indicating that the central tendencies of certain groups were similar, with considerable overlap in their distributions. In other cases, however, medians differed significantly from means, potentially affecting the reliability of comparisons. Lastly, the data contained a large number of ties, which reduced the power of the Wilcoxon rank-sum test. Ties limited the test's ability to detect differences between groups, further complicating the analysis of group-level variations.[22]

As stated in the aim section, we hypothesized that a change in student knowledge would lead to a change in medication handling/usage, making medication use safer and more appropriate. In general, one cannot expect that various activities in a single day will increase students' action competences, and a survey such as this one, which was based on relatively few multiple-choice questions, may not reliably measure the development of action competence in all its complexity.[23] Studies like this can, however, provide an indication of whether the foundation for increased action competences is present in students, so the study focused on specific knowledge and skills objectives (i.e., the foundation for any potential increase in action competences).

The study has several strengths, which indicated high validity. First, the data collection covered almost the entire geographical area of Denmark, and had a high response rate (100% for the pre-intervention survey and 88% for the post-intervention survey). Second, it is in general quite unusual for a relatively short teaching intervention to have such a strong and consistent effect on students' knowledge months later, which was the case here. Third, the questions in the survey were designed to cover all the learning objectives of the activities in the intervention, and the learning objectives were directly related to the activities of the SMT intervention, resulting in strong alignment among the learning objectives, the SMT educational activities, and the evaluation. This contributed positively to content validity[24] related to whether the content of the evaluation was relevant and representative of the targets being measured. Fourth, the population size increased the validity (pre-intervention survey 1, n=1394; post-intervention survey 2, n=949) making the estimates more robust, and in general the p value is more stable and reliable for larger samples.[22]

Conclusion

We conclude that there were statistically significant differences in primary school students' knowledge about medicine after their participation in the SMT intervention led by community pharmacists. These results support existing research and highlight the effectiveness of the SMT educational intervention. Students retained their new knowledge about medication 1–2 months after the SMT intervention. This new knowledge will hopefully lead to the rational handling of medication later in life.

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Figure 1. Program for the teaching activities of the SMT intervention