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# The effects of the provision of mineral water in schools on pupils' beverage consumption

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## Summary

The aim of the present study was to investigate the effects of mineral water provision within the classroom on pupils' beverage consumption. A controlled intervention study was conducted with 232 secondary school pupils from two types of schools: Hauptschule and Gymnasium.

The mineral water provided was consumed in both types of school involved and furthermore had positive effects on the pupils' mineral water consumption. However the effects were stronger in the Hauptschule than in the Gymnasium. Mineral water provision in the Hauptschule led to an improvement in pupils' overall beverage intake at school. Further positive effects were found on drinking quality (percentage of water in the overall beverage intake). No intervention effect on the consumption of sugar-containing beverages was found.

Regular mineral water provision within the classroom can be considered as an appropriate setting-based health promotional intervention on the environmental level, particularly in the Hauptschule. However, it becomes apparent when implementing mineral water provision in this setting, structural aspects should be taken into further consideration.

**Keywords**: mineral water, beverage consumption, intervention study, school, health promotion, children and adolescents

## Introduction

Adequate fluid intake and sufficient hydration status is associated with positive effects on cognitive performance and mood amongst school children [1]. The German Nutrition Society (DGE) recommends that children drink 1000 to 1500 mL per day – depending on their age [2].

Beverages considered particularly suitable to fulfil a person's fluid requirement are non-sweetened drinks, for instance mineral and tap water, as well as herbal and fruit teas. Drinks containing sugar i. e. soft-drinks, fruit juices and fruit nectar should only be sparingly consumed and are not recommended as daily beverages [3].

Various studies have discovered that in Germany a majority of children fail to meet the recommended beverage intake [4] or have an insufficient fluid status [5]. Furthermore, in children as well as in adolescents the consumption of sugar-containing beverages is clearly too high (more than two glasses per day) [4, 6].

Children and adolescents from families of lower socio-economic status consume considerably more soft-drinks than those of middle or higher socio-economic status [6]. Routinely high consumption of sugar-containing beverages increases the risk for overweight and obesity [7–10].

Against this background, children's and adolescents' beverage consumption is an important approach in health promotion. The school setting is considered particularly suitable through which virtually all pupils from various backgrounds can be reached.

In a recent study in primary schools, Muckelbauer and colleagues [11, 12] could show that an increase in water consumption can be attained by the installation of a water fountain. So far, no study has examined whether

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[1] German secondary education includes different types of schools. The Gymnasium (year 5 to 12) is the highest type of secondary education and designed to prepare pupils for university study. The Hauptschule (year 5 to 9) teaches at a slower pace and prepares pupils for vocational education.

**Please tick how many glasses you drank…**
**… YESTERDAY at home <u>for breakfast</u>.**

| Beverage \ Amount | ¼ of a glass | ½ of a glass | ¾ of a glass | 1 glass | 1 ½ glasses | 2 glasses | 3 glasses |
|---|---|---|---|---|---|---|---|
| Mineral water/ Sparkling water | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Tap water | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Soft-drinks i.e. coke, fanta, iced tea, energy-drinks, fruit drink | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Fruit juice/ Fruit nectar | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Diluted fruit juice | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Coffee/Tea | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Milk and milk drinks i.e. milk, cocoa | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other Beverages (please name): | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Fig. 1: **Extract of the 24-h recall questionnaire**

similar effects can be obtained in secondary schools, with mineral water available directly within the classroom. Furthermore it is not clear whether or not the different school structures (pupils, curricula, and lesson organization) influence the effects the intervention has.

## Study hypotheses

The aim of the present study "Trinken im Unterricht" („Drinking during lessons") was to examine the effects of mineral water provision within the classroom among secondary school pupils. The main focus was on the request of the mineral water provided and whether the intervention could lead to higher mineral water consumption in general, higher overall beverage intake and an improved drinking quality. In addition, the study explores a possible transfer effect connected to a decrease in the intake of sugar-containing beverages.

## Method

### Design

A controlled intervention study was conducted between September and November 2012. For the intervention, bottled mineral water was provided in the classrooms over a period of eight weeks, free of charge. Furthermore two lessons were held covering various aspects of healthy drinking. To assess beverage consumption, a questionnaire was conducted in both intervention and control group at two times of data collection, at baseline (T1) and post-intervention (T2). The questionnaire was carried out in the classroom using standardized conditions when possible (same day and time). For every pupil the amount of bottles taken within the eight week intervention period was also documented.

### Participants

Sixth and seventh year pupils were recruited from two schools of each school type Hauptschule and Gymnasium. The intervention schools were recruited first and matching control schools were purposely recruited to obtain a balanced representation of school structure and regional similarity. A further selection criterion was the absence of a water fountain and geographical proximity to the town of Schwäbisch Gmünd. Prior approval of the study was obtained by the local education authority. Written parental consent was received for all participating pupils. Altogether 303 pupils were recruited for the study. Eighteen pu-

[2] The water provided was bottled mineral water, either still or carbonated.

pils failed to provide consent forms to allow participation; three were excluded due to insufficient language skills.
A total of 232 adolescents had complete and plausible (daily beverage consumption > 0.4 L and < 5 L) data for both times of data collection, at baseline (T1) and at eight weeks follow-up (T2).

### Intervention

The health promotional intervention was setting-based and took place mainly at the environmental level: mineral water bottles were provided within the classroom over an eight week period. In terms of participation the pupils were involved in the choice of mineral water. The preferred brand of mineral water was provided and could be accessed freely in the classroom of the Hauptschule. In the Gymnasium the bottles had to be kept in a lockable cupboard within the classroom.
The pupils could help themselves to the mineral water bottles and had to document the amount taken in the corresponding lists. The return of all empty bottles was expected. The mineral water offered was intended only for use at school; bottles were not allowed to be taken home. No regulations were made concerning drinks brought from home. To ensure a smooth process class representatives were nominated in the intervention schools; regular visits by study assistants also contributed in supporting the project. No regulations were made in the control groups, merely the questionnaire was conducted.
On the behavioural level, two practice-oriented educational sessions were held in which different methods and experiments were used. These lessons were used to address various topics such as fluid loss, fluid requirements, energy content of different beverages as well as recommendations regarding beverage intake. The first lesson was conducted at the beginning of the intervention period and used also to formulate rules for drinking during lessons. These rules were designed to maintain the quality of the lessons despite the change in drinking behavior. The second lesson was held at week five and designed to refresh and deepen the acquired knowledge.

### Measures

The mineral water demand was measured using class lists documenting every bottle taken. These lists were placed next to the crates of mineral water.
Beverage consumption was assessed using a 24-hour recall questionnaire (paper-pencil) (◆ Figure 1). This method is suitable for large samples, can be completed with a whole class at once, is inexpensive, requires little equipment and is simple to complete. Moreover it does not strain the pupils nor does it influence their behaviour [13]. The beverage-targeted 24-hour recall was based on the instrument Muckelbauer and colleagues [14] used among primary school children.
The 24-hour recall asked for the type of beverages and the number of glasses of which were consumed at different time intervals. The intervals were: "yesterday at home for breakfast", "yesterday at school", "yesterday at lunchtime", "yesterday between lunchtime and dinner", "yesterday at dinner" and "yesterday between dinner and going to bed". A number of beverage categories were listed; additional beverages could be specified separately.
According to the amount of beverages consumed the number of glasses was ticked. The volume of one whole glass equalled 200 mL. The identification of the right amount was facilitated though a variety of appropriate cups and bottles, brought along by the study assistants. The questionnaire always referred to the immediate preceding school day. From the data collected the beverage consumption at school (yesterday) as well as the total beverage consumption for the whole day (yesterday) could be aggregated. When calculating the total beverage consumption all categories were added, with the exception of the category "milk and milk drinks". The categories "soft-drinks" and "fruit juice/fruit nectar" were aggregated in one category: "sugar-containing drinks". Drinking quality was determined by the percentage of water ("mineral water/sparkling water" and "tap water") in the overall beverage intake.
The classification in „underweight", „normal weight" and „overweight" was based on the body mass index (BMI) criteria by Kromeyer-Hauschild et al. [15]. A two-sided migration background was present when a pupil reported that either they themselves immigrated to Germany from another country and at least one parent was not born here; or both parents immigrated and/or don't have German nationality [16].

### Statistical analyses

Data were analysed using the statistical analysis software SPSS, version 19. Mean values and standard deviations (SD) are stated as statistical figures. Differences between types of schools and study groups (i. e. Hauptschule vs. Gymnasium and intervention vs. control, respectively) were examined using unpaired t-tests and chi-square-tests.
Two-way repeated measures analyses of variance were performed to test the intervention effects on beverage consumption. This procedure was used in order to test to what extent the intervention and control groups differed in dependent variables (group) and to what extent the dependent variables changed between T1 and T2 (time). Furthermore they were used to test if intervention and control groups differed with regard to changes in the dependent variables

| | Hauptschule | | Gymnasium | |
|---|---|---|---|---|
| | **Intervention group (n = 68)** | **Control group (n = 50)** | **Intervention group (n = 65)** | **Control group (n = 49)** |
| Age [years] | 11.6 ± 1.0 | 12.1 ± 0.8** | 11.0 ± 0.4 | 11.0 ± 0.3 |
| Sex [females in %] | 36.8 | 50.0 | 47.7 | 61.2 |
| Height [m] | 1.52 ± 0.10 | 1.58 ± 0.09** | 1.51 ± 0.07 | 1.51 ± 0.07 |
| Weight [kg] | 46.6 ± 11.7 | 54.5 ± 14.0** | 40.9 ± 7.8 | 41.3 ± 9.6 |
| BMI [kg/m2] | 19.9 ± 3.7 | 21.6 ± 4.4* | 17.9 ± 2.6 | 18.0 ± 3.3 |
| BMI-categories (KROMEYER-HAUSCHILD)<br>- underweight [%]<br>- normal weight [%]<br>- overweight [%] | <br>5.1<br>61.0<br>33.9 | <br>4.0<br>62.0<br>34.0 | <br>9.2<br>78.5<br>12.3 | <br>10.6<br>78.7<br>10.5 |
| Migration background [amount with migration background in %] | 33.8 | 12.0* | 9.2 | 8.2 |

Tab. 1: **Characteristics of the pupils at baseline (T1)** (Mean ± SD or %)
Unpaired t-test or chi-square-test within a school type: * p < 0.05, ** p < 0.01

| | Hauptschule (n = 118) | Gymnasium (n = 114) | p* |
|---|---|---|---|
| **Beverage consumption - at school [mL]** | | | |
| Mineral water | 408 ± 478 | 710 ± 593 | < 0.001 |
| Tap water | 71 ± 185 | 93 ± 246 | n.s. |
| Sugar-containing beverages (soft drinks; fruit juices/fruit nectar) | 450 ± 515 | 316 ± 348 | < 0.05 |
| Diluted fruit juice | 160 ± 341 | 246 ± 342 | n.s. |
| Overall beverage intake | 1133 ± 608 | 1389 ± 551 | n.s. |
| Percentage of water in overall beverage intake [%] | 43.5 ± 37.5 | 56.1 ± 32.7 | < 0.01 |
| | | | |
| **Beverage consumption - whole day [mL]** | | | |
| Mineral water | 776 ± 727 | 1.075 ± 878 | < 0,01 |
| Tap water | 152 ± 361 | 157 ± 386 | n.s. |
| Sugar-containing beverages (soft drinks; fruit juices/fruit nectar) | 670 ± 716 | 456 ± 461 | < 0.01 |
| Diluted fruit juice | 231 ± 441 | 338 ± 459 | n.s. |
| Overall beverage intake | 1943 ± 893 | 2111 ± 826 | n.s. |
| Percentage of water in overall beverage intake [%] | 47.3 ± 30.9 | 56.0 ± 30.0 | < 0.05 |

Tab. 2: **Beverage consumption of the pupils at baseline (T1) by school type** (Mean ± SD)
*Unpaired t-test

(time x group). The effectiveness of the intervention is proved when the last-mentioned effect is significant. If the p-value is less than .05 the null hypothesis is rejected.

## Results

Intervention and control groups did not significantly differ with regard to sex in either school types; neither did the BMI-distribution in the participating Gymnasium (◆ Table 1). In the participating Hauptschule the pupils of the intervention group were younger, smaller and lighter than those of the control group ($p < 0.01$); more frequently a migrant background was reported in the intervention group.

◆ Table 2 reveals beverage consumption according to the beverage-targeted 24-hour recall at first time of data collection (T1) separated by school type. Compared to the Gymnasium, the pupils of the Hauptschule drank significantly less mineral water and more sugar-containing drinks both at school as well as throughout the whole day. Moreover the pupils' drinking quality (percentage of water in the overall beverage intake) in the Hauptschule was more unfavourable.

As can be seen in ◆ Figure 2, the mineral water provided within the classroom was consumed by pupils in both school types. However the mean amount of mineral water consumed in the Hauptschule (395 ± 220 mL per school day) was considerably greater than in the Gymnasium (150 ± 85 mL per school day) ($p < 0.001$).

The effects of the intervention are demonstrated in ◆ Tables 3 und 4. The intervention led to significant effects in mineral water consumption in both school types at school and throughout the whole day: In the intervention group of the Hauptschule mineral water intake increased by around 300 mL (compared to baseline) with regard to the time at school as well as when considering the whole day. In contrast the mineral water intake of the control group decreased or remained the same. The changes differed significantly between the intervention and control groups (time x group: $p < 0.001$ and $p < 0.05$, ◆ Table 3). In the Gymnasium the mineral water consumption of the intervention group remained unchanged during the intervention period; whereas, the amount decreased in the control group – with regard to considerably higher values at T1. The changes differed significantly between the intervention and control group (time x group: $p < 0.05$ and $p < 0.001$).

In the intervention group of the Hauptschule the intervention led to an increase in overall beverage consumption at school compared to control group (time x group: $p < 0.01$). No effects could be found when considering the overall beverage consumption over the whole day. In the Gymnasium the intervention had no effect on overall beverage consumption, neither at school nor when the whole day was considered (time x group: p = n. s.). A considerable improvement in drinking quality could be found in the pupils of the Hauptschule when considering the time at school as well as the whole day. Changes between the intervention and control group were significant in both cases (time x group: $p < 0.05$).

No significant intervention effects in sugar-containing beverage consumption could be found in either school type.

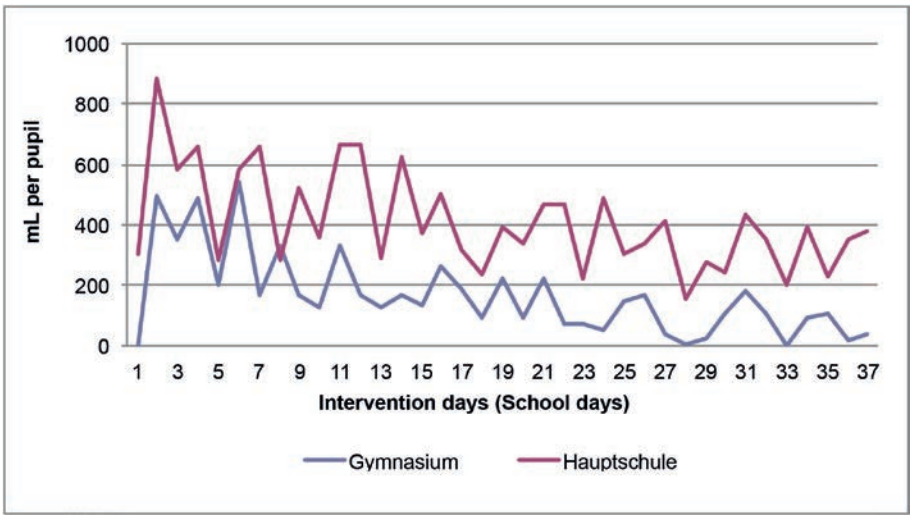


Figure 2: : **Request of the mineral water bottles provided within the classroom** (Mean)

## Discussion

Drinking behaviour was notably less favourable amongst the participating sixth and seventh year pupils attending the Hauptschule compared to the Gymnasium. Assuming that compared to the Gymnasium more pupils from families of a lower socio-economic status attend a Hauptschule, findings of Rabenberg and Mensink [6] would be confirmed. They state that children and adolescents from families of lower socio-economic status consume considerably more sugar-containing beverages and less water than those from families of middle or higher socio-economic status. The intervention effects also differed between the school types. This study demonstrates that when mineral water is provided within the classroom it is consumed by pupils. Of particular note is that the demand was very high at the beginning, but subsided

somewhat in the course of the intervention period – assumingly due to its loss of novelty value.
The mineral water demand and the effect on mineral water intake were greater in the pupils of the Hauptschule compared to those attending the Gymnasium.
This is probably due to different structures. The pupils of the Hauptschule had a main classroom, which only they had access to and in which they were mainly taught. Within the Gymnasium lessons often took place in specific subject related class-

| | Intervention group (n = 68) | | Control group (n = 50) | | p * | | |
|---|---|---|---|---|---|---|---|
| | T1 | T2 | T1 | T2 | Time | Group | **Time x Group** |
| **Beverage consumption - at school [mL]** | | | | | | | |
| Mineral water | 315 ± 386 | 684 ± 514 | 536 ± 559 | 455 ± 603 | < 0.05 | n.s. | < **0.001** |
| Sugar-containing beverages | 347 ± 483 | 217 ± 411 | 590 ± 529 | 440 ± 433 | < 0.05 | < 0.01 | **n.s.** |
| Overall beverage intake | 905 ± 564 | 1090 ± 777 | 1442 ± 530 | 1252 ± 686 | n.s. | < 0.001 | < **0.01** |
| Percentage of water in overall beverage intake [%] | 47.7 ± 39.5 | 71.5 ± 36,1 | 38.0 ± 34.1 | 38.4 ± 37.6 | < 0.01 | < 0.001 | < **0.05** |
| **Beverage consumption - whole day [mL]** | | | | | | | |
| Mineral water | 760 ± 720 | 1.041 ± 748 | 798 ± 745 | 780 ± 846 | n.s. | n.s. | < **0.05** |
| Sugar-containing beverages | 606 ± 717 | 413 ± 644 | 757 ± 713 | 597 ± 730 | < 0.05 | n.s. | **n.s.** |
| Overall beverage intake | 1867 ± 948 | 1796 ± 1.084 | 2047 ± 813 | 1827 ± 997 | n.s. | n.s. | **n.s.** |
| Percentage of water in overall beverage intake [%] | 50.2 ± 30.8 | 66.6 ± 32.3 | 43.4 ± 30.9 | 44.1 ± 30.9 | < 0.05 | < 0.01 | < **0.05** |

Tab. 3: **: Intervention effects in beverage consumption of the pupils of the Hauptschule** (Mean ± SD)
*Two-way repeated measures analysis of variance

| | Intervention group (n = 65) | | Control group (n = 49) | | p * | | |
|---|---|---|---|---|---|---|---|
| | T1 | T2 | T1 | T2 | Time | Group | **Time x Group** |
| **Beverage consumption - at school [mL]** | | | | | | | |
| Mineral water | 575 ± 551 | 559 ± 561 | 890 ± 606 | 650 ± 552 | < 0.01 | < 0.05 | < **0.05** |
| Sugar-containing beverages | 291 ± 308 | 181 ± 307 | 351 ± 396 | 349 ± 459 | n.s. | n.s. | **n.s.** |
| Overall beverage intake | 1278 ± 557 | 1155 ± 544 | 1536 ± 513 | 1375 ± 594 | < 0.01 | < 0.05 | **n.s.** |
| Percentage of water in overall beverage intake [%] | 50.6 ± 32.6 | 51.9 ± 36.5 | 63.4 ± 31.6 | 58.3 ± 36.2 | n.s. | n.s. | **n.s.** |
| **Beverage consumption - whole day [mL]** | | | | | | | |
| Mineral water | 863 ± 810 | 869 ± 876 | 1.358 ± 894 | 952 ± 778 | < 0,001 | n.s. | < **0.001** |
| Sugar-containing beverages | 408 ± 424 | 262 ± 360 | 518 ± 504 | 483 ± 619 | n.s. | < 0.05 | **n.s.** |
| Overall beverage intake | 1943 ± 856 | 1760 ± 817 | 2327 ± 738 | 2037 ± 776 | < 0.01 | < 0.05 | **n.s.** |
| Percentage of water in overall beverage intake [%] | 51.0 ± 31.1 | 53.3 ± 35.1 | 62.7 ± 27.4 | 57.4 ± 31.9 | n.s. | n.s. | **n.s.** |

Tab. 4: **Intervention effects in beverage consumption of the pupils of the Gymnasium** (Mean ± SD)
*Two-way repeated measures analysis of variance

rooms and for this reason a frequent change of classrooms was necessary. In addition, other classes were taught in the main classroom. Thus, the access to the mineral water was difficult at times.

Moreover, at the beginning of the intervention the pupils of the Gymnasium (especially in the control group) reported a higher mineral water intake at school than those of the Hauptschule. Thus, the pupils of the Gymnasium took mineral water to school more frequently before and due to the partly difficult access also maintained this habit throughout the intervention period (results not shown). This is also made clear, by the fact that the pupils of the Gymnasium report considerably higher mineral water consumption at school than the amount of water from the bottles consumed. Among the pupils of the Hauptschule, however, the amount of mineral water consumed and the amount of water consumed from the bottles were relatively similar. The significant increase in mineral water consumption of the pupils of the Hauptschule at school is certainly partly due to the fact that they had more potential in terms of an increase in intake, compared to the pupils of the Gymnasium. At baseline the mineral water intake was considerably lower in pupils of the Hauptschule compared to those of the Gymnasium. Through the intervention it could be achieved that similar amounts of mineral water were consumed in both school types. This increase in mineral water consumption in the intervention group of the Hauptschule led to an increase in overall beverage consumption at school. Therefore, at the end of the intervention period the pupils of the Hauptschule drank nearly the same amount at school as the pupils of the Gymnasium. This is of particular interest because adequate hydration is an important prerequisite for concentration and readiness to learn in school [17, 18]. The fact that in terms of the overall beverage consumption no further intervention effects could be determined could also partly be explained because the pupils already drank a lot at baseline. Thus, the DGE's recommended daily beverage intake [2] were exceeded in all study groups. Furthermore, the drinking quality determined by the percentage of water in the overall beverage intake improved considerably within the pupils of the Hauptschule. This is particularly pleasing since at baseline water covered less than half of the beverage intake in this group. Against this background these pupils could benefit from the intervention as their drinking quality especially at school was particularly unfavourable.

Interestingly, transfer effects on the consumption of sugar-containing beverages could not be achieved in any of the study groups. Despite the increase in mineral water consumption, these drinks were continuously consumed in equal amounts. Thus, the initial hope to reduce the consumption of sugar-containing drinks by increasing mineral water consumption could not be fulfilled. Muckelbauer et al. [12] report similar findings: The installation of water fountains led to an increase in water consumption without decreasing the amount of sugar-containing beverages consumed in primary school children. A US-American study also shows an increase in water consumption through the provision of drinking water in the school cafeteria without any reduction in consumption of sugar-containing beverages [19]. From a psychological point of view the consumption of water and sugar containing beverages may represent two different behaviours which follow different drinking motives: e. g. thirst quenching vs. taste (Theory of Triadic Influence [20]).

Consequently, the increased consumption of mineral water may not necessarily affect those motives associated with the consumption of sugar-containing drinks. However, it cannot be precluded that a sequential transfer effect might occur when the increased mineral water consumption becomes a habit in its course other drinking motives might change.

## Limitations

When interpreting the results, it should be taken into consideration that the data obtained are based on self-report and that the 24-hour recall only allows a rough calculation. Due to the given time intervals in the 24-hour recall a tendency to overreporting beverage intake can be assumed. Moreover the mean outdoor temperature dropped over the intervention period explaining the general decrease in beverage consumption. However these issues are of no concern when interpreting the intervention effects, as they affected intervention and control groups alike.

Finally, it should be noted that there were significant group differences in the intervention and control groups of the Hauptschule. The differences in age and resultant anthropometric parameters are rather small and therefore negligible. Especially relevant is the different proportion of pupils with a migrant background. However, since the proportion was higher in the intervention group, the results can be seen rather as proof that the intervention is also effective in schools with a high percentage of immigrants. Due to the relatively short intervention period it remains open whether the favourable changes in beverage consumption are sustainable and become permanent habit.

## Conclusion

In the context of this study, it could be demonstrated that the provision of mineral water within the classroom can be considered a promising,

setting-based health promotional measure aimed at environmental change, especially beneficial in the Hauptschule. This is especially interesting in the light that pupils of this school type more often show unfavourable drinking habits.
It also became clear, that structural aspects should be taken into consideration when implementing mineral water provision in this setting. Particularly a main classroom is of importance. If a frequent classroom change cannot be avoided an alternative form of provision should be considered e.g. a central supply point in the school's kiosk or the caretaker's office.

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**Conflict of interest**
The authors declare no conflict of interest according to the guidelines of the International Committee of Medical Journal Editors.

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