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## CLINICAL TRIAL STUDY

### The Short- and Long-term Effectiveness of the WhyDairy? School-based Nutrition Education Intervention: A Randomized Controlled Trial

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#### Abstract:

##### Background:

Despite the known health benefits of dairy products, their daily consumption continues to decline in many populations, particularly in pre-adolescents and adolescents.

##### Objective:

The primary objective of the cluster randomized controlled trial was to assess whether a school-based intervention enhanced with a web-based component, known as WhyDairy? was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products.

##### Methods:

Grade 7 students (n=175) in 10 Southwestern Ontario schools were randomized by the school, into intervention or control. Intervention schools received the WhyDairy? intervention with a website component while control schools received a DFO education program. Intervention schools were further randomized to receive follow-up contact, through monthly emails, or no follow-up contact. A questionnaire, consisting of three surveys (knowledge, FFQ, and intention), was delivered at baseline, post-intervention, and follow-up.

##### Results:

All groups significantly increased their knowledge post-intervention but only intervention schools with follow-up email contact maintained this positive change in knowledge. No groups saw significant changes in dietary behaviour. The email campaign was successful in reaching parents but did not result in high engagement or changes in student outcomes.

##### Conclusion:

The results of this study demonstrate the effectiveness of a school-based intervention enhanced with a web-based component in changing student knowledge regarding dairy products and the engagement of the website during the intervention period. Future work should consider longer durations to see changes in dietary behaviour and more targeted approaches during follow-up periods.

**Keywords :** Adolescents, Dairy products, Intervention, T2D, Obesity, Osteoporosis.

#### Article History

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## 1. INTRODUCTION

Dairy products are a convenient source of vitamins, minerals, and protein necessary in the diets of pre-adolescents and adolescents for strengthening bones during the important pubertal years of growth [1 - 4]. Additionally, consumption of recommended levels of dairy products has been shown to con-

tribute to a reduced risk of chronic disease development, including obesity [5], T2D [6], cardiovascular disease [6], and osteoporosis [7, 8]. However, despite the known health benefits of dairy products, their daily consumption continues to decline in many populations, particularly in pre-adolescents and adolescents. As dairy products can be a food used to address dietary inadequacies, promote health, and prevent disease later in life, their low consumption is a concern for children and adolescents who are developing eating habits that will carry into adulthood.

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Previous research has highlighted components and characteristics of nutrition interventions, including dairy, that is likely to be effective [9 - 11]. Schools are recognized as an appropriate setting and location to implement dietary interventions as they provide a place in which consistent and reliable information is delivered to students of all ages with diverse ethnic and socioeconomic backgrounds [12 - 15]. In addition, knowledge can be used to mediate behaviour as increased knowledge regarding healthy choices has been shown to increase consumption of healthy foods [16, 17]. Previous research has also shown that nutrition behaviours can be both established and altered in schools [12 - 15]. These school-based interventions may also be enhanced through the use of strategies that reach beyond the classroom, such as specialized web-based programs [18, 19].

Follow-up is often overlooked as a component of school-based nutrition interventions. A 2016 review found that over 75% of studies conducted no follow-up at all post-intervention, and of the studies that did conduct follow-up, most reported a failure of participants to maintain changes seen post-intervention [11]. Measuring outcomes beyond the immediate post-intervention period is necessary to determine whether effects persist across time. As well, it is possible to incorporate follow-up strategies into this period to determine which techniques can be used to maintain, or even augment, positive outcomes.

To address the issue of low consumption of dairy products by youth, we developed a school-based intervention enhanced with a web-based component that targeted Grade 7 adolescents. The objective of the study was to determine whether the novel intervention was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products. Effects were measured over the short and long-term. A secondary objective of the study was to assess the effectiveness of a parent e-mail campaign as a follow-up strategy to the intervention in impacting website use and student knowledge, behaviour, and intentions. The outcomes related to the use of the web-based component of the intervention are described in the previous publication [20]. We hypothesized that the novel school-based intervention would be more successful in changing students' knowledge, behaviour, and intentions to consume dairy products. We also hypothesized that the parent email campaign would lead to additional differences in the intervention group as parent engagement with emails would translate to further improvements in student's knowledge and behaviour regarding dairy products.

## 2. MATERIALS AND METHODS

### 2.1. Participants

Participants were recruited from 12 grade seven classrooms at 10 schools in Southwestern Ontario who agreed to be a part of the study (including Guelph, Kitchener/Waterloo, Burlington). Students were invited to participate in the study through invitation letters distributed by the classroom teacher. The racial/ethnic breakdown of the participants was not determined. Lack of participation was mainly due to failure

to return signed consent forms or absenteeism on study days involving survey completion. The study was approved by the Research Ethics Board at the University of Guelph (REB # 14NV037), as well as by the Wellington Catholic District School Board (WCDSB) and individual Christian School principals/directors.

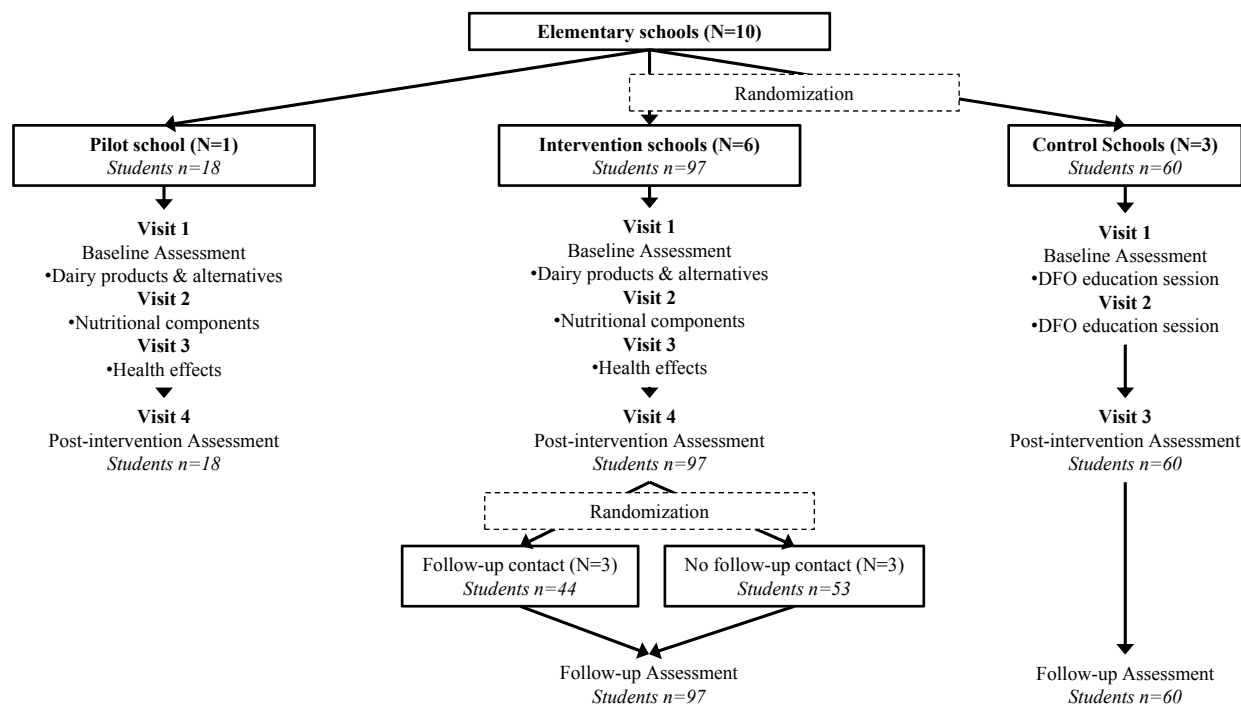
### 2.2. Study Design Cluster

This study was a school-based cluster Randomized Controlled Trial (RCT). The intervention was first piloted in a local private school to assess the feasibility of intervention delivery and success of planned activities. For the RCT schools, nine elementary schools in Southern Ontario were block-randomized (using blinded envelopes) based on school board (Private or Catholic) into intervention with no follow-up email contact (INT n=3), intervention schools with follow-up email contact from June to October 2016 (INT+FU n=3), or control with no follow-up email contact (CON n=3) treatment. Following randomization, schools were told their assignment as this dictated the number of visits and time required. Data was collected from the pilot school and combined with the three INT schools that did not receive follow up, for a total of n=4 schools for the INT group. Researchers delivered the intervention and were therefore not blinded to the allocation of the schools; however, students were unaware of their allocation or the purpose of the study.

### 2.3. Control and Intervention Treatments

The control schools received the Dairy Farmers of Ontario (DFO) education program. This program is a free service to teachers and provides interactive, curriculum-connected in-class workshops for elementary schools in Ontario, Canada. The program was taught by a DFO educator (a retired school teacher trained by the DFO), with supervision by the lead researcher, at two research visits (Fig. 1). All research visits were approximately two weeks apart, therefore, control school visits spanned approximately four weeks.

The intervention schools received the WhyDairy? intervention, which was developed by the lead researcher. Development of the WhyDairy? intervention was informed by behaviour change theories (Social Cognitive Theory [21] and the Theory of Planned Behaviour (TPB) [22]) to address constructs such as behavioural capability, attitude/knowledge, perceived control, outcome expectation, goal setting, among others. The WhyDairy? intervention was also based on previous research which identified factors that could be targeted, including: knowledge and misconceptions of dairy products; health benefits of dairy products and alternatives; and fun and engaging lessons that incorporate games [23, 24]. Dairy alternatives, such as soy milk and soy yogurt, were included in the intervention material, as opposed to solely dairy-specific foods, in order to meet curriculum guidelines and be consistent with Canada's Food Guide [25]. WhyDairy? was developed as a web-based program, and the intervention included both school-based visits (delivered in class to all students and which used the web program as a teaching tool), as well as additional web-based material that students could access voluntarily on their own [20].



**Fig. (1).** Randomization and participant flow through intervention.

The intervention material was taught over three 20 to 40-minute school visits (Fig. 1). The total intervention period spanned approximately six to eight weeks. See Sypes *et al.*, 2018 [20] for a more complete description of the research visits. At the end of each visit, students were asked to develop a positive S.M.A.R.T. (Specific, Measurable, Achievable, Realistic, Time-sensitive) behavioural goal regarding dairy product and alternatives. Visits were both didactic and interactive and researchers followed a script to ensure consistency across schools. Researchers navigated the website content (including games) during intervention visits and students were encouraged to voluntarily access the website outside of class time and at home [26].

The follow-up email campaign consisted of five emails sent once a month to parents during the months between post-intervention measurements and the final follow-up measurement visit. The emails contained general information about the intervention, links to the intervention website, and had themes such as “Calcium and Bone Health” and “Protein in Dairy and Alternatives”.

#### 2.4. Primary Outcomes Assessment

Assessment occurred in the students’ classroom at baseline, post-intervention, and at a follow-up visit. Students completed a 20-minute survey under the direction of the lead researcher who led the class through the questions. The survey, which included multiple-choice and Likert scale options, assessed demographic characteristics of participants, such as age and gender, and consisted of three components: knowledge of dairy products and alternatives, behaviour or intake of dairy products and alternatives, and intention to consume dairy products and alternatives.

##### 2.4.1. Knowledge of Dairy Products and Alternatives

Knowledge was assessed using a researcher-developed knowledge test (that is both valid (Cronbach’s alpha of 0.7) and reliable (Pearson correlation of 0.82) consisting of 11 True/False or Yes/No questions as no valid or reliable dairy knowledge tool existed. Six categories were selected to test all aspects of dairy knowledge based on their importance to dairy nutrition and relevance to school curriculum; what are dairy products and alternatives, intake recommendations and serving size, overcoming barriers to dairy intake, nutrients in dairy products and alternatives, misconceptions about dairy products and health benefits of dairy products and alternatives.

##### 2.4.2. Intake of Dairy Products and Alternatives

Intake of dairy products and alternatives was assessed using a modified version of the Youth Adolescent Food Frequency Questionnaire (YAQ) [27]. Modifications were performed by the lead researcher to select only dairy products or foods containing dairy products, and a question about the consumption of alternatives was added.

##### 2.4.3. Intention to Consume Dairy Products and Alternatives

The intention to consume dairy products and alternatives was measured using 17 Likert-type questions on a scale of one to seven and was developed based on the TPB [22, 28]. The tool measured beliefs about the behaviour, social norms, perceived behavioural control, and intention to consume dairy products or alternatives.

#### 2.5. Data Collection and Analysis

Responses for each question of the three questionnaires comprising the full survey were inputted and checked for

accuracy by two independent researchers. Responses for the YAQ were converted into dairy servings per day [23]. The knowledge questionnaire consisted of 11 right or wrong questions with a total possible score of 26. The Likert scale numbers circled on the intentions survey were inputted accordingly. If a student circled more than one answer, the average of the two was inputted. If they left the answer blank at the post-intervention or follow-up visit, the last observation was carried forward, therefore assuming no change.

The follow-up email campaign (which was sent to parents of students in three of the intervention schools) was tracked using MailChimp. We tracked subscribers across the five months, number of emails opened by each parent, and number of clicks within each email. Each parent was assigned a "Parent Engagement Score" to quantify their interaction with the five emails. One point was awarded for each email opened and one point was awarded for each link within an email the parent clicked on. This resulted in a total possible engagement score of ten.

## 2.6. Statistical Analysis

Students needed to be present at both baseline and post-intervention visits in order for their data to be analyzed. If students were absent at the follow-up visit, and therefore had no score for the final survey, the mean of their treatment group was used in order to keep the flow of participants to the end of the intervention and limit those lost to follow-up due to absenteeism.

All data were corrected for any scan or input errors and then checked for normalcy using the Shapiro-Wilk test of normality prior to statistical analysis. Testing for outliers was conducted by visual boxplot analysis. All outliers were left in analysis, unless otherwise stated, as visual inspection of their values did not reveal them to be extreme. Transformation of data was attempted if data were not normally distributed; however, this was rarely effective in computing normal data. Therefore, non-parametric statistical tests were used unless otherwise stated. Participants were analysed based on intention to treat. All statistical analyses were performed using IBM SPSS Statistics, Version 24 for Windows (Property of IBM Corp). The p-value was set at  $\leq 0.05$ . The Friedman test (or repeated measures one-way ANOVA for normal data) was performed to determine within-group effects across all three-time points for knowledge, behaviour, and intention. The Kruskal-Wallis test (or one-way ANOVA if data were normal) was used to determine the between-group effect. To assess any correlations between intention questionnaire variables, a bivariate correlation matrix was generated using Spearman's correlation.

Parent emails could be linked to the child's ID code and thus allowed researchers to track parent interaction with the emails and correspond this with their child's results. Therefore, students were separated into three groups based on their parent's email interaction: no follow-up emails received, follow-up emails received and engagement score of zero (follow-up, engagement-), or follow-up emails received and engagement score greater than zero (follow-up, engagement+). A one-way ANOVA was conducted to determine if the changes

in students' knowledge scores from post-intervention to follow-up were different based on their treatment condition regarding parent interaction with the follow-up email campaign. Spearman's rank coefficient was used to determine the strength of association between a parent's email engagement score and their child's change in knowledge test score from post-intervention to follow-up.

## 3. RESULTS

### 3.1. Study Population

The study population consisted of 83 males and 92 females Table 1. Mean age  $\pm$  standard deviation was  $12.3 \pm 0.5$  years. Descriptive statistics for baseline information of the treatment groups for sex, age, total dairy intake, or knowledge score is shown in Table 1. There were no significant differences in baseline knowledge scores or dairy consumption between any groups. There were differences between treatment groups with regards to schools implementing the Elementary School Milk Program (ESMP) and prior exposure to DFO educational visits (Table 1). This variable was not considered prior to randomization, but an ANCOVA did not reveal differences at baseline between groups based on prior exposure to a DFO program. Overall, approximately half our population was meeting dairy requirements as defined by Canada's Food Guide with an average intake of  $3.4 \pm 1.7$  servings of dairy per day.

### 3.2. Short- and Long-term Changes in Knowledge, Behaviour, and Intentions

A Kruskal-Wallis H test revealed no statistically significant differences in knowledge scores between groups at any time point. However, Friedman tests revealed significant differences in knowledge scores (as a percent) at different time points during the intervention period for all treatment groups. Pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. Overall, all treatment groups significantly improved their knowledge scores from pre-intervention to post-intervention ( $p < 0.05$ ); however, differences were seen among treatment groups when comparing pre-intervention to follow-up and post-intervention to follow-up as shown in Fig. 2.

With regards to dairy consumption, there were no significant changes in dairy intake within or between any group at any time point during the intervention period (Fig. 3), as assessed by a Friedman test or Kruskal-Wallis H test, respectively. Mean dairy intake for females at follow-up fell below recommendations for CON and INT schools, but not for INT+FU schools (data not shown). As well, INT+FU schools saw a high percentage of students meeting or exceeding dairy requirements (64%) at the follow-up visit compared to INT (51%) or CON (58%) schools (data not shown).

The simple association between theory constructs was examined using Spearman correlation coefficients Table 2. Total dairy intake at follow-up was weakly, but significantly, correlated with perceived behavioural control, self-assessment of control, and intention, for all three treatment groups. Intention to consume dairy products was moderately or

**Table 1. Descriptive of study population at baseline.**

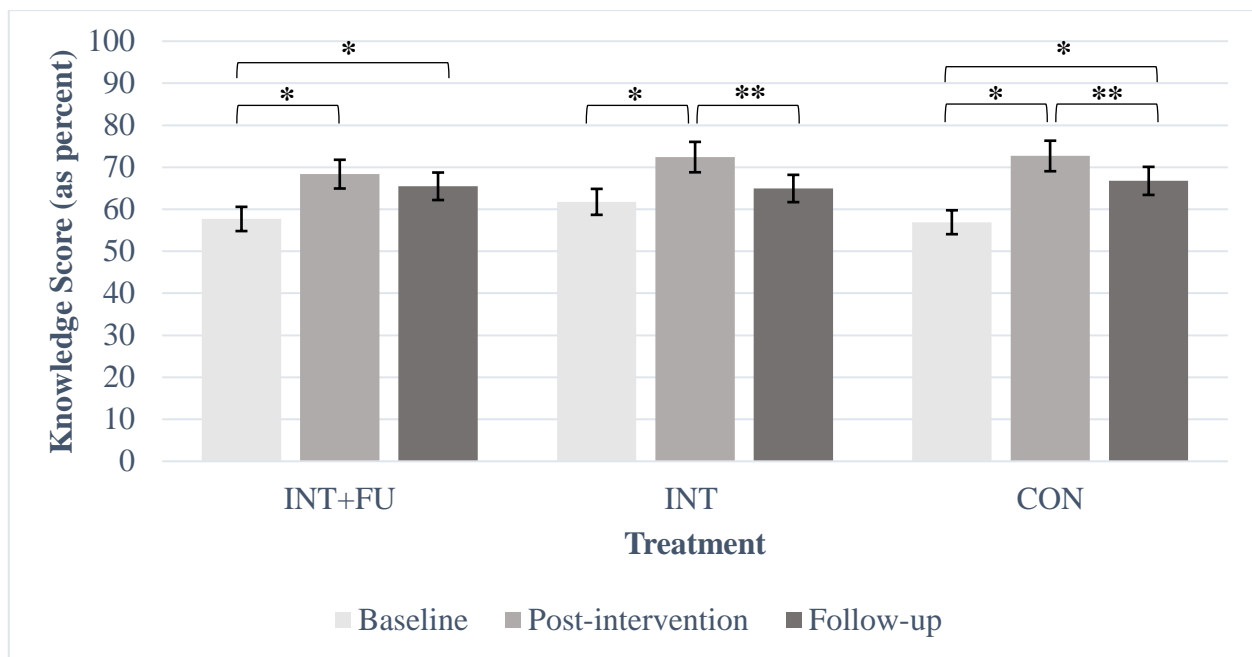
	Total (n=175)	INT (n=115)	CON (n=60)
Age <sup>1</sup>	12.3 ± 0.5	12.3 ± 0.5	12.3 ± 0.5
Gender	53% Female 47% Male	52% Female 48% Male	53% Female 47% Male
ESMP	8/10 schools 82% students	6/7 schools 84% students	2/3 schools 78% students
DFO prior	3/10 schools 41% students	1/7 schools 17% students	2/3 schools 87% students
Dairy Requirements <sup>2</sup> Meet or exceed Does not meet	51% 49%	55% 45%	47% 53%
Dairy Intake <sup>1,3</sup> Female Male	3.4 ± 1.7 3.3 ± 1.7 3.5 ± 1.6	3.4 ± 1.6 3.3 ± 1.6 3.5 ± 1.6	3.3 ± 1.9 3.3 ± 2.1 3.5 ± 1.6
Knowledge Score (/26) <sup>1</sup> Percent <sup>1</sup>	15.4 ± 3.4 59.2% ± 13.1	15.7 ± 3.5 60.3% ± 13.6	14.9 ± 3.1 57.2% ± 11.9

ESMP = School has the Ontario Elementary School Milk Program in effect DFO Prior = Class was exposed to or received the Dairy Farmers of Ontario educational sessions consistently for 3-5 years prior to entering Grade 7. Dairy Requirements = Canadian Food Guide recommended 3-4 servings/day or dairy and/or alternatives Note: INT treatment includes pilot school students

1. Values in mean ± standard deviation

2. Based on 2007 Canada's Food Guide recommended 3-4 servings of dairy and alternatives per day for children aged 9-18 years old.

3. In servings of dairy per day



**Fig. (2).** Mean knowledge scores with 95% confidence interval for each treatment group across all three time points

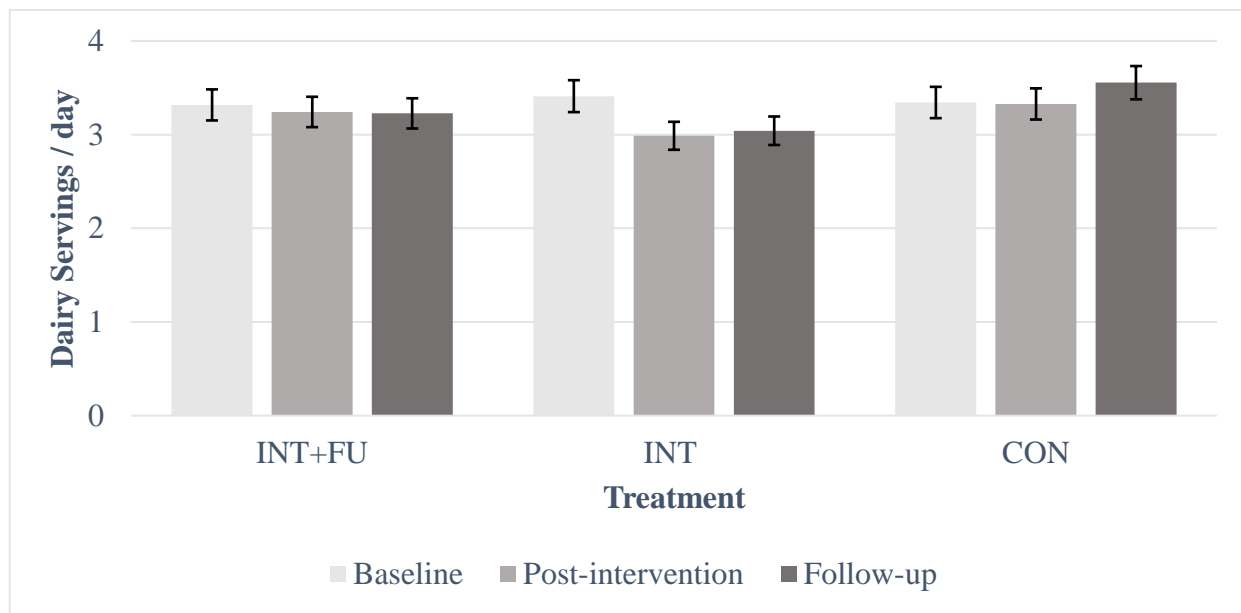
\* = significant increase in knowledge  $p < 0.05$

\*\* = significant decrease in knowledge  $p < 0.05$

INT+FU: Baseline 57.7% (13.9), Post-intervention 68.4% (13.0), Follow-up 65.5% (11.3)

INT: Baseline 59.8% (12.9), Post-intervention 69.7% (14.5), Follow-up 64.9% (12.6)

CON: Baseline 56.9% (11.8), Post-intervention 72.7% (12.0), Follow-up 66.8% (11.6)

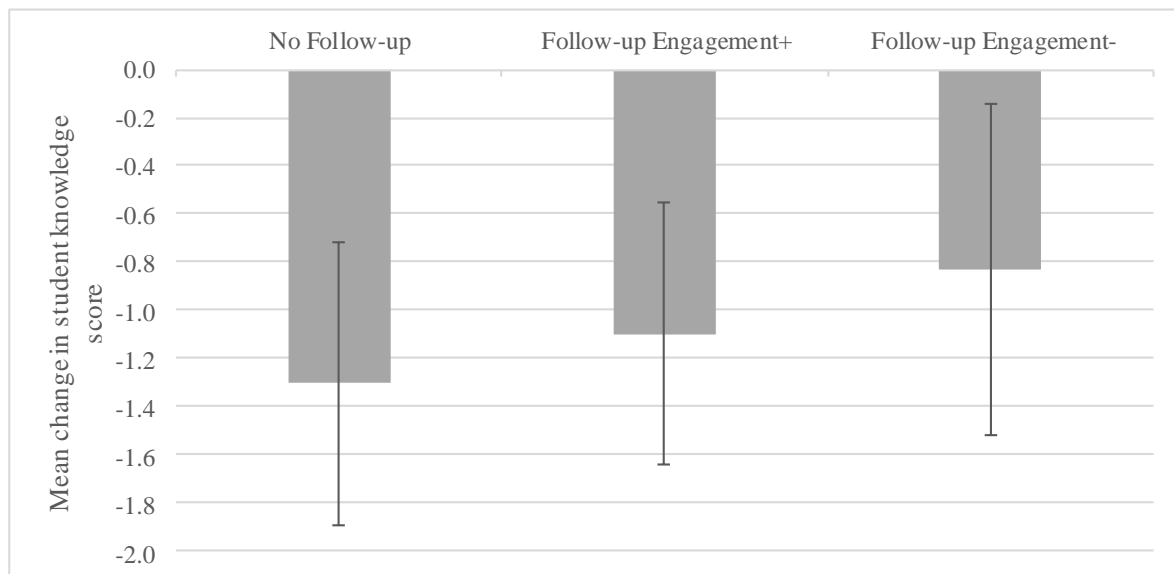


**Fig. (3).** Mean dairy and alternatives intake per day with 95% confidence interval for each treatment group across all three time points  
 Dairy servings per day as mean (SD) = INT+FU: Baseline 3.3 (1.7), 3.2 (1.9), 3.2 (1.6); INT: Baseline 3.2 (1.3), 2.8 (1.3), 3.0 (1.3); CON: Baseline 3.4 (1.9), 3.3 (1.6), 3.5 (2.0) .

**Table 2. Theory of planned behaviour correlation among theory constructs at follow-up.**

	Social Norms	Perceived Behavioural Control (PBC)	Self-Assessment of Control	Intention	Total Dairy Intake
<b>Attitudes</b>	<i>0.513**</i>	<b>0.723**</b>	<i>0.502**</i>	<i>0.503**</i>	0.109
INT	<i>0.324*</i>	0.006	0.173	0.270	-0.213
INT+FU	-0.075	<i>0.524**</i>	<i>0.582**</i>	<i>0.454**</i>	<i>0.375**</i>
CON					
<b>Social Norms</b>		<i>0.461**</i>	<i>0.362**</i>	0.268	0.149
INT		-0.048	0.084	-0.152	-0.101
INT+FU		0.133	-0.027	0.069	0.070
CON					
<b>PBC</b>			<b>0.714**</b>	<i>0.661**</i>	<i>0.353**</i>
INT			<i>0.519**</i>	<i>0.404**</i>	<i>0.419**</i>
INT+FU			<i>0.560**</i>	<i>0.627**</i>	<i>0.372**</i>
CON					
<b>Self-Assessment of Control</b>				<b>0.788**</b>	<i>0.487**</i>
INT				<i>0.522**</i>	<i>0.422**</i>
INT+FU				<i>0.677**</i>	<i>0.355**</i>
CON					
<b>Intention</b>					<i>0.526**</i>
INT					<i>0.452**</i>
INT+FU					<i>0.374**</i>
CON					

\* = correlation is significant at the 0.05 level (2-tailed)\*\* = correlation is significant at the 0.01 level (2-tailed) **bold** = strong spearman correlation coefficient of >0.70 *italic* = moderate spearman correlation coefficient of >0.50



**Fig. (4).** Mean change in student knowledge score from post-intervention to follow-up

No Follow-up: Parents did not receive emails between the end of the intervention and follow-up visit.

Follow-up Engagement+: Parents received emails during the follow-up period and opened and clicked on at least 1 email.

Follow-up, Engagement-: Parents received emails during the follow-up period but did not open or click on any emails.

strongly correlated with two variables, perceived behavioural control and self-assessment of control, for all treatment groups. There were no significant differences between treatment groups and mean ratings of any theory constructs at the three time points (data not shown).

### 3.3. Follow-up Email Campaign

Out of a total of 52 consenters in the INT+FU group, 50 parents provided correct email addresses; however, the total number of subscribers declined across the five months. The average percentage of email opens was 43%, with the highest percentage of opens recorded from Email 1 (50%) and the

lowest from Email 4 (33%). Despite the modest percentage of opened emails, only five clicks in total were recorded throughout the entire email campaign coming from Email 1 or 3.

A one-way ANOVA was conducted to determine if the changes in students' knowledge scores from post-intervention to follow-up were different based on their parent's interaction or engagement with the follow-up email campaign. The mean change in knowledge scores (Fig. 4) became increasingly positive from no follow-up (mean  $-1.3 \pm 3.7$  SD), to follow-up with engagement (mean  $-1.1 \pm 2.4$  SD), to follow-up no engagement (mean  $-0.95 \pm 2.0$  SD), but the differences between these treatment groups were not statistically significant ( $p=0.875$ ). Furthermore, a Spearman's rank coefficient was calculated to determine the strength of the association between a parent's email engagement score and their child's change in knowledge test score from post-intervention to follow-up. The coefficient was calculated to be 0.17 and this association was not statistically significant ( $p=0.381$ ).

## 4. DISCUSSION

The main objective of the study was to assess whether a school-based intervention enhanced with a web-based component was more effective than a standardized dairy education program at changing: (i) knowledge of dairy products, (ii) intentions to consume dairy products, and (iii) dietary intake of dairy products. Overall, all participants demonstrated improvements in knowledge regarding dairy products and alternatives with voluntary use of a website and there was some success of the parent email campaign in maintaining subscribers throughout the campaign period. However, no treatment groups saw changes in dietary behaviour and there was poor engagement with the follow-up emails. Future work should consider longer durations to see changes in dietary behaviour and more targeted approaches during follow-up periods to see better engagement.

### 4.1. Post-intervention Changes in Knowledge, Behaviour, and Intention

Contrary to our hypotheses, we found no differences in knowledge about dairy products and alternatives or intake of dairy products and alternatives between our treatment groups post-intervention. There are a few potential reasons for the lack of differences between the intervention and control groups. After the intervention was complete, it was discovered that some schools were repeatedly exposed to the DFO education program for a prolonged period of time prior to the intervention beginning (87% of CON school students), while other schools had no contact (17% of intervention school students). The interaction and relationship building with the same educator for many years prior to the intervention were therefore imbalanced across treatment groups. While the WhyDairy? intervention was intended to be focused primarily on dairy products and

alternatives since previous research has suggested that targeted dietary messages lead to more successful interventions [10], it was broader in scope than the DFO program. The WhyDairy intervention spoke to dairy products, but also included alternatives, as components of an overall healthy diet compared to the control program which focused entirely on dairy products. Addressing diet more broadly may have inadvertently diffused the intended focus and message of the intervention, thus resulting in less targeted knowledge acquired by the students. The lack of difference between the treatment groups may also be due to the fact that the control schools received a shorter program, which allowed students to retain information over the short-term and recall this information sooner than the intervention students, thus reducing the natural decay of knowledge across time [29]. Finally, while this study was intended to be a randomized control trial with a control group, the DFO education program that acted as our control was not a true "treatment as usual". The educator was inconsistent in teaching between schools and directly referenced the baseline and post-intervention survey questions. These factors may have resulted in the lack of differences seen between treatment groups.

While there were no differences in knowledge about dairy products and alternatives between control or intervention groups, all three treatment groups saw significant increases in knowledge post-intervention. This is consistent with previous literature that educational interventions in schools can modify and improve knowledge regarding food and food groups in adolescents [30 - 32]. Nutrition interventions must be sufficiently long to result in changes in knowledge in adolescents [33]. It has been suggested that 10-15 hours of education [34] through interventions spanning between five to 13 weeks [15, 35, 36] are needed to improve adolescents' health and nutrition knowledge. While the WhyDairy? intervention spanned a period of six to eight weeks, our intervention was able to elicit changes in knowledge with only one hour and 40 minutes of total instructional time and the control program was also able to improve students' knowledge with only one hour of total instructional time. This suggests that with content and teaching strategies that are appropriate and targeted to the age group, nutrition knowledge can be changed in a short amount of time.

Despite the change in knowledge across all treatment groups, there were no changes in behaviour as measured by dairy and alternative intake. This result is in contrast to literature that suggests nutrition knowledge can be at least a partial mediator of food intake [16, 17], although it is clear that knowledge is only one of many influential factors over food behaviour [17]. Other important factors include: perceived consequences of the behaviour; attitudes and beliefs about the behaviour; skills and confidence; social and physical environments; and barriers and facilitators to dairy product consumption, such as knowledge, taste preference, habits, availability, and convenience [23]. Although we attempted to specifically target barriers and facilitators to dairy product intake, there were several that we were unable to reach, such as availability and cost. Moreover, we were unable to fully extend the reach of the intervention to include direct parental and home contact, although we attempted to do so by sending

materials home with students. We measured these factors and constructs within our survey and did see some correlations between perceived control and self-assessment of control, as well as self-assessment of control and intention to consume dairy products. However, despite these correlations, our intervention may not have been long enough or had enough instructional time to result in true behaviour change [10, 11, 15, 35, 36]. This is very difficult to achieve in a school-based setting unless the intervention is directly integrated into the academic curriculum. In addition, our population consumed high levels of dairy at baseline, with over half of the participants meeting dietary recommendations. This may be due to the close proximity to rural farm land and the strong agricultural influence on the area, both of which can increase milk consumption [37, 38]. Consequently, there was a limited need for behaviour change since the majority of the population was already meeting their dietary targets, and our intervention encouraged them to meet, but not exceed, these recommendations. So, while increasing nutrition knowledge may be an important initial step to modifying behaviour and can be changed rather quickly, ensuring this translates into behaviour change will likely require a more intensive intervention and greater control over variables such as parental involvement and participant baseline characteristics [39].

#### 4.2. Follow-up Email Campaign and Student Changes in Knowledge

A significant issue with school-based nutrition interventions has been previously identified as a lack of follow-up [11]. The WhyDairy? intervention attempted to address these issues by including a parental email campaign and a follow-up data collection visit five-months post-intervention. Interestingly, the INT+FU schools were the only group to maintain their knowledge at the follow-up visit and demonstrate a significant increase in knowledge from baseline to the follow-up visit almost five months later, with no significant decrease in knowledge at any time point. The other two treatment groups, CON and INT, both experienced a decay of knowledge across time with a significant decrease in knowledge at follow-up as compared to post-intervention. It has been widely suggested, and should be a focus of future interventions, that without the reinforcement of knowledge and newly learned concepts, decay in knowledge can occur [29].

The retention of knowledge in the INT+FU group may be related to the parental email campaign during the follow-up period. Almost all parents (92%) remained on the email list and just under half of the parents (43% average) opened the emails. While there was low engagement with the emails, as measured by clicking the links provided, this is only one method of quantifying the success of the email campaign. The content of the emails may have been enough information to retain some impact.

In our intervention, we failed to see the translation of parental engagement with student changes in behaviour. This may be due to multiple reasons such as the low engagement with the emails, the decrease in website visits during the follow-up period, the passive nature of the email campaign, and the timing of emailing parents over summer holidays.



Therefore, future research that incorporates parents as a target of their intervention should focus on actively engaging the parents, changing the home food environment, and utilizing parents to model healthy behaviours at a more convenient time [11, 40 - 42].

**4.3. Limitations**

Due to the nature of this study, a number of limitations exist. Firstly, our study may have been underpowered to detect significant differences. While our initial recruitment of schools and students would have led to a study that was almost sufficiently powered, student absences and lack of consent led to a smaller study population than anticipated. This also speaks to the issues with recruitment due to restrictions placed by the school board and the schools. Secondly, the intervention program and time with the students was limited due to school board and individual school restrictions. Length, depth, and intensity of the intervention have been suggested as important components for the success of changing adolescent behaviour [10, 11]. The outcome measurements were derived from a survey with three questionnaires based on self-report. While adolescents are capable of completing these types of surveys [43, 44], social bias, recall bias, and lack of clear understanding may have influenced the accuracy of their reporting [45]. The fact that in each subsequent measurement, students reported eating less each time than at previous time points is consistent with other trials using FFQs and is a bias in this type of repeated measurement [46]. The non-significant findings in this study, therefore, may be a result of this bias and it is recommended that future research incorporates measures of food intake that may be more reliable across time. We chose to use a brief FFQ to satisfy time constraints and limit burden on the students, even though we recognized that this method is less reproducible than other more resource-intensive methods such as food records and dietary recalls. As well, students gained knowledge during the intervention about correct serving sizes and therefore may have more appropriately reported their dairy intake at post-intervention and follow-up. Although it is unclear whether this would lead to an over- or under-estimation of intake at baseline.

**Table 3. Summary of findings: Effectiveness of the WhyDairy? intervention and the associated website and parent email components.**

<ul style="list-style-type: none"> <li>• A school-based dairy intervention with a website component is effective in creating short-term changes in knowledge</li> <li>• Changes in knowledge can be maintained up to five-months post-intervention with parent involvement through a targeted email campaign</li> </ul>
<ul style="list-style-type: none"> <li>• Longer, more intense interventions may be necessary to see changes in dietary behaviour</li> </ul>
<ul style="list-style-type: none"> <li>• Future research should consider developing targeted interventions with web components to enhance student engagement and more active strategies to reach the home environment, including parents</li> </ul>

**CONCLUSION**

Overall, the results of this study Table 3 provide supportive evidence that knowledge regarding dairy products and alternatives can be changed through a school-based

intervention with supportive web-based components and that the increase in knowledge can be sustained over five months with follow-up strategies. However, the change in knowledge did not translate into a change in behaviour, potentially due to the high baseline dairy consumption of our population or the relatively short length of time spent interacting with students. In addition, parents were receptive to receiving emails as a follow-up strategy and almost half opened the emails. Despite this, the vast majority of parents did not engage with the email by clicking on any links or resources provided within the email text. Future research should consider the school environment as an effective location to educate students about foods for health and could supplement the lessons with web-based components. Parents can be an effective supplement to school-based interventions and more targeted approaches that actively engage parents could result in changes amongst students in future research.

**ETHICS APPROVAL AND CONSENT TO PARTICIPATE**

The study was approved by the Research Ethics Board at the University of Guelph (REB # 14NV037).

**HUMAN AND ANIMAL RIGHTS**

Animals did not participate in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008.

**CONSENT FOR PUBLICATION**

All subjects provided written informed consent prior to undergoing any of the tests related to this study.

**AVAILABILITY OF DATA AND MATERIALS**

Not applicable.

**FUNDING**

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**CONFLICT OF INTEREST**

M. Racey was supported by a Highly Qualified Personnel award from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). DFO and OMAFRA had no role in the design, analysis or writing of this article. The authors declare no potential conflicts of interest.

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Declared none.

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