Diabetes mellitus: preliminary health-promotion activity based on service-learning principles at a South African national science festival

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Abstract

Objectives: To investigate the effects of a service-learning-based health promotion elective in influencing knowledge of diabetes mellitus (DM) and ways to prevent it.

Method: A computer-based quiz, an information poster, interactive models and a take-home information leaflet on DM were developed as part of an exhibit during the 2009 National Festival of Science and Technology held in Grahamstown, South Africa. Predominantly school students visited the exhibit and took part in the quiz and other educational activities.

Results: The majority of the 119 junior and 332 senior quiz participants were male students attending government schools in the Eastern Cape, South Africa. After an educational intervention, there was significant improvement in the junior quiz participants' overall percentage knowledge scores (p-value = 0.024), while the senior quiz participants showed a markedly significant improvement in the overall percentage knowledge scores (p-value < 0.001). The results showed significant gender differences for both the pre- and post-intervention mean percentage scores among both groups, with better scores for female participants.

Conclusion: The health-promotion elective was successful in raising awareness of DM. This approach may offer an additional tool that can be used in the continuous, concerted health promotion activities and advocacy by all healthcare professionals to address the prevention of DM.

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Introduction

Globally, more than 220 million people have diabetes mellitus (DM), with more than 80% of DM-related deaths occurring in low- and middle-income countries.[1] In 2010, approximately four million deaths (6.8% of global all-cause mortality) in the 20-79 age group were linked to DM, with a higher proportion of DM deaths occurring in women.[2] If this problem continues to increase, by 2025 more than 333 million people are predicted to develop DM, with prevalence rates expected to double in sub-Saharan Africa.[3] In South Africa, based on a number of epidemiological studies in selected communities for people 30 years or older, the prevalence rate for DM was 5.5%, with most cases occurring in older people and with a higher prevalence in urban settings.[4]

A comparison of self-reported DM in urban and rural populations was reported in the first South African Demographic Health Survey in 1998, when stratified cross-sectional household national surveys were used to gather data. It is important to note that prevalence rates above 15 years were 2.9% for males and 4.4% for females in urban areas, whereas it was only 1.7% for males and 2.7% for females in rural areas. The same national survey highlighted another critical aspect when the urban population was subdivided into a "no education" subpopulation. In this group, the prevalence rate for males was 2.9%, but for females it was 6.8%.[5] This highlights the complex multilayered interplay of factors fuelling the increase in chronic noncommunicable diseases (CNCDs) such as DM in South Africa. These factors include lack of education, low socioeconomic status and increased globalisation and urbanisation. DM and obesity are both considered chronic epidemics, related to global trends of physical inactivity and consumption of calorie-dense foods, sweetened beverages and larger food portions.[6]

In the Eastern Cape, the province in which this health-promotion activity was conducted, the 1998 survey highlighted that self-reported DM above 15 years was 2.7%

for males and 3.5% for females.[7] Data from the District Health Information System in Grahamstown showed that in 2009, the average prevalence of DM was 4.85% in the primary healthcare clinics.[8]

In response to the challenges of DM in Grahamstown in the Eastern Cape, members of the Faculty of Pharmacy at Rhodes University designed a final-year pharmacy elective based on service-learning and health-promotion principles to create basic awareness of DM as a chronic condition among young attendees of the 2009 National Festival of Science and Technology (SciFest).

Method

Three final-year pharmacy students designed an interactive quiz to assess the pre-intervention level of knowledge of DM among SciFest attendees. The quiz was intended for senior school attendees. This was followed by an educational intervention and then a post-intervention questionnaire. The quiz was piloted in local schools and changes were implemented based on feedback obtained.

The quiz was then adapted to a specially designed computer programme, BKnow®, to be used at SciFest. The BKnow® presenter software was used to integrate multiple-choice questions into a Microsoft PowerPoint® presentation. The quiz slides were designed so that the participants could choose one of the options in each slide. Each possible option was tagged with a pop-up consequence, congratulatory for a correct choice, or an explanation as to why the chosen option was incorrect. Demographic data of the participants and their responses to the quiz were logged as extensible mark-up language (XML). For the analysis of the logged XML, an interpreter was written in the Python® programming language to convert the raw logs into tables of responses that could be analysed statistically.

The pharmacy students also prepared a poster, interactive models and a bilingual English and isiXhosa (the predominant local language) take-home information leaflet on DM. The poster was used as a visual aid to explain DM and its causes, symptoms, complications and prevention. A model was designed to depict the vital organs that would be affected by uncontrolled DM. The information leaflet was made available to all who attended the exhibit at SciFest so that a broader audience could be reached. This health-promotion activity formed part of the "Pharmaceutical care" elective, which was approved by and offered at Rhodes University. The three final-year pharmacy students who participated in the elective signed a confidentiality form and the activity was approved by the Ethics Committee of the Faculty of Pharmacy.

Use of computer keyboards

After pilot testing, the quiz was included in the SciFest health-promotion exhibit. Senior school students and members of the community who had left school took part in the quiz designed in 2009 and junior school learners took part in a quiz designed for SciFest 2007.[9] The participants were guided on how to use the computer keyboard before attempting to do the quiz. This was an important consideration because many of the participants were from township and rural schools and may not have used a computer before. It was explained to the participants that they only needed to use three keys on the computer keyboard. A red sticker was placed on the enter key, a green sticker on the up arrow and a yellow sticker on the down arrow. By doing this, the participants could easily identify which three keys needed to be used. They were told that the up and down arrows were to be used to scroll through the various answer options displayed on the computer screen and the enter key was to record the answer they thought was correct.

The computer quiz consisted of three sections: a pre-intervention quiz, followed by the intervention and then the post-intervention quiz. The junior quiz consisted of seven pre-intervention questions and the senior quiz consisted of eight pre-intervention questions. Each question was on a different slide with multiple-choice answer options. A score was calculated for each participant, depending on the number of correct answers obtained in the quizzes. The pre-intervention scores appeared on the screen once the participants had completed all the pre-intervention quiz questions. The intervention slides then appeared and, for each question asked on the pre-intervention slide, there was a corresponding intervention slide that consisted of simple text and pictures to explain the correct information. The intervention slides were followed by the post-intervention quiz, which repeated the questions in the pre-intervention quiz. If the answer given was correct, a congratulatory message would appear, followed by the next question. If the answer was incorrect, the relevant intervention slide with information regarding the correct answer would appear. After reading the intervention slide, the participants would click on the red key and the next post-intervention quiz slide would appear. The participants' post-intervention quiz scores appeared at the end of the post-intervention questions and in this way, they were made aware of the differences, if any, between their pre- and post-intervention scores.

Participants could not go back to alter the answers to their questions once they had committed to an answer by clicking on the red key. Clicking the escape key started a new quiz. The pharmacy students, at least one pharmacy lecturer coordinating the course and SciFriends (assistants at the exhibit who could speak isiXhosa) were on hand to assist with the use of the computers where necessary. This simple and effective system made it easy for people to complete the quiz, even if they had no or minimal prior knowledge of using a computer.

Statistics

Dependent t-tests on test percentage scores and McNemar χ^2 tests on the percentage of correct answers obtained for each question before and after the intervention were used to assess whether the intervention made a difference in the understanding of diabetes. Independent t-tests and ANOVA procedures were performed to test whether age, gender and type of school affected test percentage scores before and after the intervention. Means and standard errors were calculated for pre- and post-intervention scores. All tests were performed using the statistical programming language R, and significance was set at the 0.05 level. A separate analysis was done for the junior and senior school presentations.

Results

Junior school quiz

The demographics of the participants were captured by five initial questions in the presentation and 119 participants took part. The results show that 15 participants (12.6%) were nine years or younger, 41 participants (34.5%) were either 10 or 11 years old, 52 (43.7%) participants were either 12 or 13 years old, and 11 participants (9.2%) were 14 years or older. Of the total number, 38 (31.9%) were female and 81 (68.1%) were male. Regional distribution shows that 110 (92.4%) were from the Eastern Cape. The remainder were from other South African provinces. The demographics show that 71 participants (59.7%) attended a government school, while the remaining 48 (40.3%) attended an independent school.

The first assessment regarding knowledge was to determine the number of participants who knew what a chronic disease was. Of these, 56 participants (47.1%) answered correctly, while the remaining 63 (52.9%) answered incorrectly.

Pre-intervention results

The results from the pre-intervention questions (Table I) show that the participants had reasonable prior knowledge of DM, its effects and how it may be prevented (overall percentage score: 75.9%; range: 65.5-83.2%).

Comparison of pre- vs. post-intervention results

Of the participants who took part in the pre-intervention questions, 74.8% (n = 89) continued through to the post-intervention questions. McNemar's dependent χ^2 test was used and the results are shown in Table II.

The intervention resulted in a significant increase in correct responses to question 3 (p-value = 0.013), as well as a significant improvement in the participants' overall percentage scores (p-value = 0.024).

The results show significant gender differences for both the pre- and post-intervention mean percentage

Table I: Frequencies and percentages of correct answers for the junior quiz (n = 119)

Question	Frequency	Percentage
1. True or false: Diabetes mellitus occurs when you have too much sugar in your blood.	87	73.1
2. Can children have diabetes mellitus?	94	79.0
3. Are weakness, increased thirst, increased appetite, loss of weight, headache, dizziness and fainting signs of diabetes?	85	71.4
4. When diabetes is not controlled, can it cause damage to the heart, kidneys and eyes?	94	79.0
5. What can you do to try to stop yourself from getting diabetes?	99	83.2
6. Can children be obese (too fat)?	95	79.8
7. If I am not physically active (e.g. do not play, do not walk, do not do household chores, do not exercise) and do not eat healthy food, could I be unhealthy and get fat?	78	65.5

Table II: Junior quiz observed frequencies and percentages of correct responses for the pre- and post-intervention questions, and the means ± standard errors of pre- and post-intervention percentage scores (n = 89)

Question	Pre-intervention	Post-intervention	P-value (one-sided)
1. True or false: Diabetes mellitus occurs when you have too much sugar in your blood.	66 (74.2%)	74 (83.2%)	0.059
2. Can children have diabetes mellitus?	70 (78.7%)	66 (74.2%)	0.278
3. Are weakness, increased thirst, increased appetite, loss of weight, headache, dizziness and fainting signs of diabetes?	61 (68.5%)	74 (83.1%)	0.013*
4. When diabetes is not controlled, can it cause damage to the heart, kidneys and eyes?	70 (78.7%)	75 (84.3%)	0.191
5. What can you do to try to stop yourself from getting diabetes?	75 (84.3%)	74 (83.1%)	0.500
6. Can children be obese (too fat)?	69 (77.5%)	75 (84.3%)	0.143
7. If I am not physically active (e.g. do not play, do not walk, do not do household chores, do not exercise) and do not eat healthy food, could I be unhealthy and get fat?	58 (65.2%)	66 (74.2%)	0.077
Mean ± standard error	75.3 ± 4.0%	80.9 ± 3.9%	0.024*

* = significant at 5%

scores (pre: males 71.6 ± 2.1%, females 85.0 ± 3.1%, p-value<0.001; post: males 77.5±2.4%, females 87.6±3.3%, p-value=0.011). No significant differences in mean percentage scores were found between participants from government and independent schools either before (government 75.4 ± 2.3%, independent 76.5 ± 2.8%; t = -0.2705, df = 87, p-value = 0.787) or after (government 79.6 ± 2.5%, independent 82.8 ± 3.2%; t = -0.7667, df = 63, p-value = 0.446) intervention. Neither pre- nor post-intervention mean percentage scores were significantly different in the different age groups. The mean ± standard error percentage scores of the participants in the age groups were: nine years or under (pre: 77.1 ± 5.2%, post: 71.4 ± 6.1%), 10 or 11 years (pre: 75.6 ± 3.1%, post: 81.9 ± 3.1%), 12 or 13 years (pre: 75.8 ± 2.8%, post: 83.7 ± 2.8%) and 14 years or over (pre: 75.3 ± 6.0%, post: 64.3 ± 9.1%; analysis of variance: pre: F = 0.0252, df = 3, 115, p-value = 0.995; post: F = 2.2677, df = 3, 85, P = 0.086).

Senior school quiz

As in the junior quiz, the demographics of the 332 participants in the senior quiz were captured in the first five questions. The results show that 24 participants (7.2%) were 13 years or younger, 59 participants (17.8%) were either 14 or 15 years old, 120 (36.1%) participants were either 16 or 17 years old and 129 participants (38.9%) were 18 years or older. Of the total number, 130 (39.2%) were female and 202 (60.8%) were male. Regional distribution shows that 308 (92.8%) attended school in the Eastern Cape, while the remaining 24 (7.2%) attended school in the other South African provinces. The demographics show that 257 participants (77.4%) attended or had attended a government school, while the remaining 75 (22.6%) attended or had attended an independent school.

In the first assessment regarding knowledge, 225 participants (67.8%) knew what a chronic disease is, while the remaining 107 (32.2%) did not.

Pre-intervention results

The results from the pre-intervention questions (Table III) show that the participants had fair prior knowledge of DM, its effects and how it may be prevented (overall percentage score: 57.5%; range: 30.4-76.5%).

Comparison of pre- versus post-intervention results

Of the senior quiz participants who took part in the pre-intervention questions, 66.3% (n = 220) continued through to the post-intervention questions. McNemar's dependent χ^2 test was used and the results are shown in Table IV.

The intervention resulted in a significant increase in correct responses to questions 2, 3, 4 and 8 (P < 0.001 for each) and question 6 (P = 0.005), and a markedly significant improvement in the participants' overall percentage scores (P < 0.001).

Table III: Frequencies and percentages of correct answers for the senior quiz (n = 332)

Question	Frequency	Percentage
1. Diabetes is a condition where …	101	30.4
2. What is insulin?	183	55.1
3. Some of the common symptoms of diabetes are …	254	76.5
4. Fifty-eight per cent of type 2 diabetes all over the world is caused by ...	223	67.2
5. Diabetes could lead to ...	232	69.9
6. Diabetes can be prevented only if …	123	37.0
7. Who is most at risk of developing type 2 diabetes?	230	69.3
8. What are the results of uncontrolled diabetes?	182	54.8

Table IV: Senior quiz observed frequencies and percentages of correct responses for the pre- and post-intervention questions, and the means ± standard errors of pre- and post-intervention percentage scores (n = 220)

Question	Pre-intervention	Post-intervention	P-value (one-sided)
1. Diabetes is a condition where …	70 (31.8%)	74 (33.6%)	0.342
2. What is insulin?	118 (53.6%)	152 (69.1%)	< 0.001*
3. Some of the common symptoms of diabetes are …	169 (76.8%)	192 (87.3%)	< 0.001*
4. Fifty-eight per cent of type 2 diabetes all over the world is caused by ...	150 (68.2%)	178 (80.9%)	< 0.001*
5. Diabetes could lead to ...	162 (73.6%)	156 (70.9%)	0.209
6. Diabetes can be prevented only if …	78 (35.5%)	100 (45.5%)	0.005*
7. Who is most at risk of developing type 2 diabetes?	157 (71.4%)	167 (75.9%)	0.110
8. What are the results of uncontrolled diabetes?	122 (55.5%)	158 (71.8%)	< 0.001*
Mean ± standard error	58.3 ± 3.2%	66.9 ± 3.4%	< 0.001*

* = significant at 1%

The results show significant gender differences for both pre- and post-intervention mean percentage scores (pre: males 54.6 ± 1.7%, females 62.0 ± 2.1%, p-value = 0.007; post: males 63.1 ± 2.2%, females 72.6 ± 2.7%, p-value = 0.004). No significant differences in mean percentage scores were found between participants from government and independent schools either before or after intervention (pre: government 56.5 ± 1.5%, independent 61.2 ± 2.8%, t = -1.366, df = 108, p-value = 0.175; post: government 66.1 ± 1.9%, independent 69.9 ± 3.8%, t = -0.798, df = 59, p-value = 0.428). Pre- and post-intervention mean percentage scores were significantly greater in the older participants**.** The mean ± standard error percentage scores of the participants in the age groups were: 13 years or under (pre: 45.3 ± 4.6%; post: 59.6 ± 6.7%), 14 or 15 years (pre: 44.3 ± 2.9%; post: 53.4 ± 3.8%), 16 or 17 years (pre: 56.5 ± 2.1%; post: 66.3 ± 2.7%) and 18 years or over (pre: 66.9 ± 2.0%; post: 74.9 ± 2.6%; analysis of variance: pre: F = 16.4, df = 3, 328, P < 0.001; post: F = 7.8, df = 3, 216, P < 0.001).

Discussion

The computer-based quizzes were effective in raising awareness of DM and its prevention, especially among the young attendees at SciFest, and may serve as a means of addressing the rapidly increasing CNCD disease profile in developing countries such as South Africa.[10] Once considered a rare condition in young people, type 2 DM is now regarded as a global health problem by the World Health Organization that is reaching epidemic levels[11] in this group. Participation of the 119 junior and 332 senior quiz participants in the health promotion activity was shown to be important in creating awareness. It is also important to target students and adolescents who are making diet and lifestyle choices that impact on their health.[12-14] It is essential that health promotion activities such as these reach out to young people in developing countries where access to information may be limited, especially in rural areas. The high number of senior school participants is probably the result of more senior school learners attending SciFest, as important subject and career choices are made during senior school.

The fact that 92.4% of the junior quiz participants were from the Eastern Cape and that 59.7% of these attended government schools is indicative of interest in government schools to give learners the chance to attend SciFest, which is encouraging. The majority of the senior quiz participants (92.8%) attended schools in the Eastern Cape, with 77.4% attended or having attended a government school. Also, in both the pre- and post-intervention questions among the junior and senior quiz participants, no significant difference in mean percentage scores between government and independent school attendees were noted. It was encouraging to note that many participants were willing to participate in the computer-based quizzes, despite having minimal or no exposure to using computers at school. The novelty of using a computer, the simplicity of the instructions of using only three keys on the computer keyboard and the educational interventions facilitated by pharmacy students and SciFriends may have encouraged participants.

The first assessment regarding knowledge was to determine whether participants knew the meaning of the term "chronic disease". Only 47.1% of the junior quiz and 67.8% of the senior quiz participants answered correctly. This could possibly be due to participants not fully understanding the terminology.[3] Although there was no significant difference between the age groups in the junior quiz, there was an increase in the post-intervention mean percentage scores for the 12- or 13-year-olds and the 10- or 11-year-olds. In the senior quiz, the older participants had both pre- and post-intervention mean percentage scores that were significantly higher.

Making dietary and lifestyle changes, increasing physical activity, adding nutritional choices, encouraging family participation and decreasing sedentary activity are considered the general principles for successful interventions.[15] School-going adolescents represent a unique target group for active learning and interventions, as they are generally eager to learn about new ideas they are introduced to, take responsibility for their health, are involved in decision making and are able to make changes, implement prevention strategies and participate in skill-based interventions.[16-18]

The junior quiz participants showed that they had prior knowledge of DM, its effects and prevention of the condition, with 75.9% answering correctly. Only 57.5% of senior quiz participants gave correct responses to the senior quiz. There was an increase in the junior participants' response to understanding that if they were not physically active and did not eat healthily, they could become unhealthy/overweight. Senior quiz participants showed a significant increase in understanding the role of insulin as well as in the symptoms, causes and prevention of DM.

A significant gender difference was noted in both the pre- and post-intervention questions in the junior and senior quiz participants. It is heartening to see that female participants were more aware of DM. In South Africa, overweight and obesity is a major problem beginning in early age, with 10% of females aged 15 to 24 years and up to 56% of urban black women being obese.[10,19] The alarming increase in levels of obesity among adolescents is shown by a doubling in prevalence over the past 20 years. If no preventative measures are implemented, this problem will continue to expand.[20] Our "obesogenic" society has changed the way in which we perceive our bodies. This, together with a tendency towards other chronic conditions, such as hypertension and hyperlipidaemia, will further increase DM prevalence.[21] Therefore, behavioural interventions are the focus of most researchers in the prevention and reduction of chronic conditions.[22] Thus, the use of interactive, fun computer-based health-promotion activities may offer a creative way of reaching out to young students.

Limitations of the study

Limitations of the study included having only five weeks to develop the quizzes and to pilot-test them, as SciFest was held five weeks after the start of the first university term in the academic year. As a result, pilot-testing focused on grade 10 and 12 learners and did not include all senior grades, i.e. grades 8 to 12. Validity tests could not be carried out, as the DM quizzes were designed with different numbers of items and scales. Participation in the quizzes could not be restricted, as SciFest was open to all members of the community. Research-based controlled activities could not be implemented, as participants ranged from learners from all groups as well as adults who had left school, and all were eager to participate in this health-promotion-focused exhibit. The post-intervention quizzes were not completed by all the participants and some did not interact with the models and posters. Reasons for this included prior commitments, such as attending other workshops, and departing transportation arranged by the schools. The educational intervention only occurred during SciFest; while this resulted in a positive outcome, further intervention and continuous access to information are needed to bring about sustained changes in knowledge that could influence lifestyle modifications.

Conclusion

The exhibit at SciFest provided an opportunity for pharmacy students to interact with the community and to raise awareness of DM and possible ways of preventing it. Although the SciFest attendees had some prior knowledge of DM, interaction with the health-promotion activity resulted in an increase in knowledge. A variety of continuous health-promotion activities could result in increased awareness of these CNCDs. Targeting the youth may be particularly important to reduce the incidence of DM and other CNCDs in developing countries such as South Africa.

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Declaration

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