Article

Type 1 Diabetes: A Comic Book to Empower the Youth Audience's Knowledge*

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Theme: Health, well-being, and quality of life promotion

Contributions to the field: Nursing holds a leading role in educational activities, as it fosters spaces for dialogue and promotes more humane and effective care through interaction, thereby promoting the development of healthcare practices that are not merely technical, but rather committed to the principles of popular education in health to increase knowledge of diabetes mellitus among adolescents. Furthermore, a dialogical effort will enable the development of individual and social class empowerment among adolescents, assuming a leading role and contributing to the discovery of their subjectivity to assume liberating practices in facing and overcoming social inequalities.

Abstract

Introduction: To promote active methodologies in a ludic format for health literacy through comic books and enable the empowerment of adolescents, the results of this study may equip and encourage healthcare professionals to act effectively in the prevention of diabetes and promote quality of life. **Objective:** To analyze the knowledge and empowerment dimensions of adolescent students in Vitória de Santo Antão regarding type 1 diabetes mellitus before and after an educational intervention using comic books. **Materials and Methods:** This is a quasi-experimental study with a quantitative approach, conducted with 179 adolescents. The intervention consisted of the use of a previously validated comic book, combined with the application of the adapted Diabetes Knowledge Questionnaire (DKQ) and the Youth Empowerment Scale in Health Education, evaluated at three different intervals. The analysis was performed using the marginal homogeneity test and the nonparametric Wilcoxon Test, with a significance level of 5% ($p < 0.05$). **Results:** Significant values were found regarding knowledge of diabetes after the educational intervention with comic books in all DKQ items, except items 1 and 2 ($p = 0.061$ and 0.059, respectively). There was no statistical significance in the levels of individual empowerment and social class when analyzed at two different intervals, with a p-value > 0.05. **Conclusion:** The educational intervention led to an increase in knowledge among adolescent students. However, the absence of dialogue reveals the fragile empowerment of adolescents.

Keywords (Source: DeCS)
Family relations; self-care; chronic renal insufficiency; renal dialysis; family support.

Diabetes tipo 1: cómic para empoderar el conocimiento del público juvenil

* Trabajo de final de curso presentado en el pregrado de Enfermería de la Universidade Federal de Pernambuco, centro académico de Vitória, Brasil, como requisito para la obtención del título de licenciado en Enfermería. https://repositorio.ufpe.br/handle/123456789/51857

Resumen

Introducción: Con el fin de valorar de manera lúdica las metodologías activas para la alfabetización en salud mediante cómics y favorecer el empoderamiento de los adolescentes, los resultados de este estudio pueden proporcionar y motivar a los profesionales de la salud a actuar de manera efectiva en la prevención de la diabetes y promover la calidad de vida. **Objetivo:** analizar el conocimiento y las dimensiones de empoderamiento de estudiantes adolescentes de Vitória de Santo Antão sobre la diabetes *mellitus* tipo 1 antes y después de una intervención educativa con cómics. **Materiales y métodos:** se trata de un estudio cuasiexperimental, de enfoque cuantitativo, realizado con 179 adolescentes. La intervención consistió en el uso de un cómic previamente validado, asociada a la aplicación del Cuestionario de Conocimiento Adaptado de Diabetes (QCD) y la Escala de Empoderamiento Juvenil en Educación para la Salud, evaluados en tres momentos distintos. El análisis se realizó mediante la prueba de homogeneidad marginal y la prueba no paramétrica de Wilcoxon, con un nivel de significancia del 5 % ($p < 0,05$). **Resultados:** se encontraron valores significativos sobre el conocimiento de la diabetes tras la intervención educativa con cómics en todos los ítems de la QCD, excepto en los ítems 1 y 2 ($p = 0,061$ y $0,059$, respectivamente). No se halló significancia estadística en los niveles de empoderamiento individual ni en relación con la clase social al comparar dos momentos diferentes (valor de $p > 0,05$). **Conclusión:** la intervención educativa aumentó el conocimiento de los estudiantes adolescentes. Sin embargo, la ausencia de una acción dialógica evidencia un empoderamiento limitado de los adolescentes.

Palabras clave (Fuente DeCS)
Diabetes *mellitus*; adolescente; empoderamiento; educación para la salud; tecnología educativa.

Diabetes tipo 1: história em quadrinhos para empoderar o conhecimento do público juvenil*

* Trabalho de conclusão de curso apresentado ao curso de Enfermagem da Universidade Federal de Pernambuco, centro acadêmico de Vitória, Brasil, como requisito para a obtenção do título de bacharel em Enfermagem. https://repositorio.ufpe.br/handle/123456789/51857

Resumo

Introdução: A fim de valorizar as metodologias ativas de forma lúdica para o letramento em saúde por história em quadrinhos e viabilizar o empoderamento dos adolescentes, os resultados deste estudo poderão instrumentalizar e estimular profissionais de saúde a atuarem efetivamente na prevenção do diabetes e promover qualidade de vida. **Objetivo:** analisar o conhecimento e as dimensões de empoderamento dos adolescentes escolares de Vitória de Santo Antão sobre o diabetes *mellitus* tipo 1 antes e após uma intervenção educativa com história em quadrinhos. **Materiais e métodos:** trata-se de um estudo quase experimental, de abordagem quantitativa, realizado com 179 adolescentes. A intervenção consistiu na utilização de história em quadrinhos previamente validada, associada à aplicação do Questionário adaptado dos Conhecimentos do Diabetes (QCD) e da Escala de Empoderamento Juvenil em Educação em Saúde, avaliadas em três momentos distintos. Procedeu-se à análise com o teste de homogeneidade marginal e o teste não paramétrico de Wilcoxon, com nível de significância de 5 % ($p < 0,05$). **Resultados:** Constatam-se valores significativos sobre o conhecimento do diabetes após a intervenção educativa com histórias em quadrinhos em todos os itens do QCD, exceto os itens 1 e 2 ($p = 0,061$ e 0,059, respectivamente). Verificou-se que não houve significância estatística nos níveis de empoderamento individual e de classe social quando analisados em dois diferentes momentos, por um valor de $p > 0,05$. **Conclusão:** A intervenção educativa provocou aumento no conhecimento dos adolescentes escolares. Contudo, a ausência de uma ação dialógica revela frágil empoderamento dos adolescentes.

Palavras-chave (Fonte DeCS)
Diabetes *mellitus*; adolescente; empoderamento; educação em saúde; tecnologia educacional.

Introduction

Adolescence is characterized as a life stage of intense biopsychosocial changes, marked by the transition from childhood to adulthood. This period includes emotional conflicts, intellectual development, behavioral changes, and the process of identity development (1, 2).

Adolescents are subject to significant social, cultural, and environmental influences that directly contribute to the formation of their subjectivity, rendering them more susceptible to these elements (3). At this stage, adolescents experience increased autonomy, along with the need to seek new experiences and possible lifestyle changes, which can leave them more vulnerable to health risks that may affect the entire growth and development process during this period, such as violence, accidents, alcohol and drug abuse, and the development of chronic noncommunicable diseases (4, 5).

According to a publication by the International Diabetes Federation Atlas (2021), type 1 diabetes mellitus (T1DM) is one of the most commonly diagnosed chronic diseases, especially in children, adolescents, and young adults (6). It is estimated that the total population with T1D in 2022 reached 8.75 million, of which 1.52 million (17%) were children and adolescents under the age of 20. This estimate is higher than the 2021 Atlas estimate of 1.21 million (7). In addition to the risks mentioned above, which are inherent to adolescence, there has been an increase in the number of people with T1DM at this stage of life, with the incidence growing each year due to the high incidence in many countries and increased life expectancy (6).

From the perspective of adolescent health, Brazil ranks third among countries with the highest estimated numbers of incident cases of T1DM in children and adolescents (0-19 years) per year (7). It has been found that the prevalence of this disease is increasing rapidly, corresponding to between 5% and 10% of all cases of DM worldwide (6).

When providing care to people with T1DM, health education is one of the key factors in reaching people. It must be recovered and valued, considering all the particularities of the disease and the demands it generates for effective and comprehensive control. It can therefore contribute to promoting self-care and improving treatment in the health-disease process, enabling prevention and delaying the chronic complications of diabetes and alleviating the classic symptoms (8, 9).

Health and education are always mentioned when discussing quality of life. Regardless of where it occurs, whether in healthcare or in the school environment, the interaction between the two constitutes an important path to improving living conditions, with educational practices being significant (10). In this context, health education is an important pedagogical process that entails the development of empowerment and critical-reflective thinking among those involved, enabling them to make health decisions for self-care and the development of autonomy (8, 11).

Empowerment can be understood both at the individual and at the collective or social class level. At the individual level, it refers to the psychological development of analysis and the subject's ability to acquire knowledge, think critically, and assume a leading role to intervene in the processes that determine their life, promoting their health. Social class empowerment is related to the process of critical-reflective knowledge construction, awakening political awareness in individuals to assume liberating practices in facing and overcoming social inequalities in health, with sociopolitical and cultural repercussions (11, 12).

By integrating popular knowledge with scientific knowledge, it is believed that the implementation of a ludic educational intervention, using comics as a learning resource for adolescents, can bring health benefits, stimulate critical-reflective thinking, and promote changes in high-risk behaviors and contexts of vulnerability.

In this context, the present study aims to analyze the knowledge and empowerment dimensions of adolescent students in Vitória de Santo Antão regarding T1DM before and after an educational intervention using comic books.

Materials and Methods

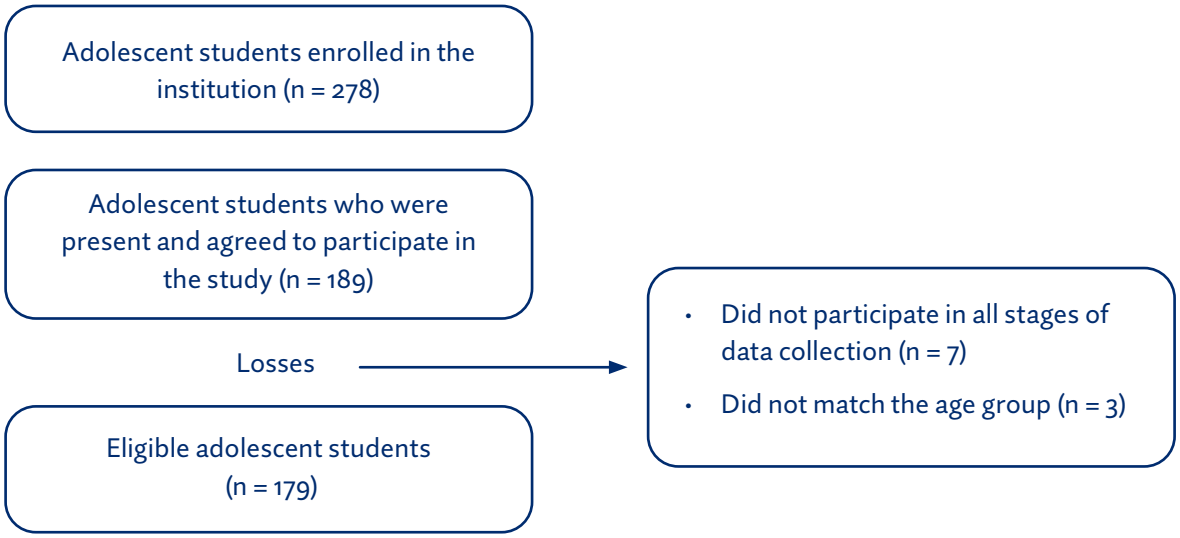
This is a quasi-experimental study with a quantitative approach. Data were collected at a reference high school in the municipality of Vitória de Santo Antão, Pernambuco, between October and November 2022.

The study population consisted of adolescent students from the aforementioned institution, totaling 278 students. The inclusion criteria were adolescent students aged between 10 and 19 years—which is the age range for adolescence recommended by the World Health Organization (13)—enrolled in the state school system, and residents of the municipality of Vitória de Santo Antão. Students who were absent on the day of the educational intervention were excluded from the study. The sample was non-probabilistic for convenience, in which 189 students were present and agreed to participate in the study, of whom seven did not participate in all stages of data collection and three did not fit the age range adopted, resulting in a final sample of 179 eligible participants. Forty days after the intervention, of the 179 eligible adolescents, only 139 responded to the research instrument. The sample loss is shown in Figure 1.

Study Protocol

First, the researchers invited the students to participate in the study, presenting the terms, objectives, and instruments used in data collection to them. The following day, the study was conducted individually in the classroom, with the teacher's permission, lasting an average of 30 minutes.

Figure 1. Adolescent Students Included in the Educational Intervention, according to Eligibility Criteria. Vitória de Santo Antão, Pernambuco, Brazil, 2023



Source: Prepared by the authors.

The data collection consisted of three stages. The first consisted of a sociodemographic questionnaire, developed by the authors, which included variables such as age, gender, marital status, employment status, romantic relationship, presence of children, living arrangements, person responsible for maintaining the household, school year, academic performance, history of repeating grades (including the period of repetition and number of times failed), problems at school, and school attendance. The questionnaire also covered diabetes, knowledge regarding the disease, whether any family members had been diagnosed (and their relationship to the respondent), and the type of diabetes mentioned.

The second stage included the application of the adapted Diabetes Knowledge Questionnaire (DKQ) by Sousa and McIntyre (14), a validated instrument that aims to assess knowledge regarding diabetes, consisting of 19 items in the form of statements to be marked as true (T), false (F), or not sure (NS). Next, the intervention was conducted using the comic book entitled "*Diabetes não é brinquedo*!" (Diabetes is no joke!), created by Rebouças and Gomes (15). After that, the DKQ was administered again so that the responses could be compared.

Finally, after using the DKQ, the Youth Empowerment Scale in Health Education (EJEduS) was applied, validated by the study by Barros et al. (16), which contains 31 items to analyze the level of empowerment that these adolescents had after the educational action with comics. Forty days after the educational intervention, a retest was performed, this time using only the DKQ and EJEduS.

Statistical Analysis

The collected data were double-tabulated in Excel spreadsheets to minimize typing errors and were then validated. In the first stage of

data collection, sociodemographic data were analyzed using descriptive statistics, performed using absolute and relative measures, using Epi Info software, version 7.2.5.0.

For the descriptive analysis of the DKQ results, absolute and relative measures were collected using Epi Info version 7.2.5.0. For the comparison of the pre-test and immediate post-test, as well as the pre-test and 40-day post-test, the marginal homogeneity test was calculated at a significance level of 5% with the support of the Statistical Package for Social Sciences (SPSS) version 29.0.

The EJEduS analysis was based on a confirmatory factor analysis to calculate the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA), with an acceptance parameter greater than 0.95 for the CFI, while for the TLI, and for the RMSEA it was lower than 0.08. The modification indexes influence the model from 3.84 onwards, which is the cutoff point according to the JASP software version 0.18.3, considering the degree of freedom for a significance level of 5%. A descriptive survey of the scale items was also conducted using absolute and relative measures and central tendency using the mean, with the support of Epi Info version 7.2.5.0. To compare the extent of empowerment after the educational intervention in the immediate post-test and 40 days later, the nonparametric Wilcoxon test was calculated at a significance level of 5% with the support of the SPSS program, version 29.0.

Ethical Aspects

This study was conducted in line with ethical principles and approved by the Research Ethics Committee of the proposing institution, in compliance with National Health Council Resolution 510/2016, under Opinion 5,657,604. The data were collected after the participants' consent and approval, and the consent of their parents/guardians, who signed the free and informed consent form. A copy of these forms was kept by the researchers, with the participants' anonymity guaranteed.

Results

A total of 179 adolescent students aged between 14 and 19 participated in the study. In the sociodemographic characterization of the participants in the health education program, there was a higher prevalence of adolescents who identified as female (88; 49.16%), single (147; 82.12%), not dating (126; 70.39%), not working (136; 75.98%), without children (165; 92.18%), living with parents and siblings (54; 30.17%), and whose father was the main maintainer of the household (61; 34.08%).

When assessing the school profile, it was found that most adolescents were in their second year of high school (69; 38.55%). In

terms of performance, 78 (43.58%) considered themselves to have average grades. Returning a grade was reported by 41 (22.91%) participants, of whom 28 (68.9%) repeated a grade once during middle school (23; 56.98%). In addition, 43 (24.02%) reported having received school warnings, and 102 (56.98%) reported missing classes only when they were sick.

Regarding the characterization of the diabetes profile of adolescents participating in the educational program (Table 1), it was found that most students had no diagnosis of diabetes (176; 98.32%), but knew someone who had the disease (112; 62.57%). In addition, 94 adolescents (52.51%) reported having relatives with diabetes, with grandparents being the most frequently mentioned (39; 41.49%). However, most stated that they did not know the type of disease that affected their relatives (62; 65.96%).

Table 1. Characterization of the Diabetes Profile of Adolescents Participating in the Educational Intervention. Vitória de Santo Antão, Pernambuco, Brazil, 2023

Factor evaluated	N	%
Do you have diabetes?		
No	176	98.32
Not sure	1	0.56
Did not respond	2	1.12
Do you know anyone who has diabetes?		
Yes	112	62.57
No	65	36.31
Did not respond	2	1.12
Does anyone in your family have diabetes?		
Yes	94	52.51
No	83	46.37
Did not respond	2	1.12
If so, who?		
Mother	1	1.06
Father	7	7.45
Grandparent(s)	39	41.49
Mother and father	1	1.06
Mother and grandparent(s)	6	6.38
Uncle/aunt (s)	12	12.77
Uncle/grandparent(s)	10	10.64
Sibling	3	3.19
Cousin	4	4.26
Other compositions	11	11.70

Factor evaluated	N	%
Which type?		
Type 1	18	19.15
Type 2	13	13.83
Gestational	0	0
Other	0	0
Type 1 and type 2	1	1.06
Not sure	62	65.96

Source: Prepared by the authors.

Table 2 shows the results related to adolescent students' knowledge regarding diabetes before and after the educational intervention with comic books (N = 179) and after 40 days (N = 139). There was a significant increase in knowledge regarding diabetes after the educational intervention with comic books in all items of the DKQ, except items 1 and 2 (p = 0.061 and 0.059, respectively), which address, in general, diabetes control based on blood glucose monitoring, and disease control based on treatment prescribed by a medical doctor.

After 40 days of implementing the health education measure, statistical significance was found in item 1 (p = 0.024), but not in item 2. However, the high frequency of correct answers at the three intervals (92.18%, 94.97%, 96.40%, 96.65%, 98.32%, 97.84%, in that order) suggests that these items may already be part of the adolescents' knowledge.

Changes in p-values were also identified between significance in the immediate post-test and values greater than 0.05 in the 40-day post-test in items 2, 8, 9, 10, and 16, related to treatment, blood glucose, diet and the duration and definition of the disease, themes that may already be part of their prior knowledge or that can be explored in greater depth in the comic book.

The confirmatory factor analysis of EJEduS covered two domains: individual empowerment through items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15, and social class empowerment through items 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, and 31 (17), which showed a multifactorial survey of CFI and TLI with values equal to 0.989 and 0.988, respectively, and an RMSEA equal to 0.072. The modification indexes influenced the exchange of item 13 from social class empowerment to individual empowerment, with a value of 20.745. By changing item 13, the multifactorial analysis revealed a CFI and TLI with values of 0.989 and 0.989, respectively, and an RMSEA of 0.070.

The application of EJEduS (Table 3) shows that, after the intervention, the items that scored the lowest averages (2.40 and 2.47) in individual and social class empowerment were precisely

those in which participants stated that they did not feel the need to seek connections and support from healthcare professionals, family, and friends, in addition to perceiving that the intervention neglected their origin, history, and culture (items 13 and 23). This result can be explained by the negative nature of the items, according to their own formulation.

The highest means, in the respective individual and social class factors, were found in item 14: 4.24 in the immediate post-test and 4.06 in the 40-day post-test, in which participants realized that they could contribute to improving the health of their colleagues, family members, and the community. Item 20 had the highest mean in the 40-day post-test (3.99), referring to motivation to help solve the health problems of family, friends, and the community. In turn, item 30 obtained the highest mean in the immediate post-test (4.19), in which participants assessed that the class showed reality, practice, and situations as they occur outside the school environment.

It was found that there was no statistical significance in the level of individual empowerment in items 5, 7, 8, 9, 10, 11, 12, 13, 14, and 15, nor in social class empowerment in items 16, 17, 18, 20, 22, 23, 24, 25, 27, 28, and 30, when analyzed at two different intervals ($p > 0.05$). In turn, statistically significant results were found in items 1, 2, 3, 4, and 6 (individual empowerment) and 19, 21, 26, 29, and 31 (social class empowerment). These items indicated that the class helped participants to adopt a stance, assert their opinions, and promote dialogue with other people. In addition, it enabled them to recognize their own needs, review their life plans, and strengthen their authenticity, helping them to have more control over themselves and greater awareness of their attitudes. It also motivated commitment to school, family, and community issues, sparked interest in contributing to a more ethical, fair, and supportive society, encouraged understanding the world in a different way, conveyed a sense of freedom, and stimulated nonviolent conflict resolution based on dialogue and solidarity.

Discussion

Regarding the participants' profile, the findings of the present study are similar to those of studies conducted with adolescents attending public schools in the municipalities of Fortaleza (Ceará) and Picos (Piauí), in terms of the prevalence of females aged between 14 and 19, most of whom were only studying and living with their parents (1, 17).

In view of their coexistence with people close to them who have DM, the adolescents demonstrated an influence on their prior knowledge regarding this disease, which may justify the statistical insignificance in items 1 and 2 in the immediate post-test, as can be seen in Table 1. In this regard, it should be noted that to plan educational measures, it is necessary to understand the context and profile of the target audience, assess and employ daily situations of the population under study, and thus grant subjects the opportunity to relate the topic addressed to their prior knowledge (18).

Table 2. Adolescent Students' Knowledge Regarding Diabetes, before and after the Educational Intervention with Comic Books (n = 179) and after 40 Days (n = 139). Vitória de Santo Antão, Pernambuco, Brazil, 2023

Questions from the Diabetes Knowledge Questionnaire	Pre-test (n/%) n = 179			Immediate post-test (n/%) n = 179			p – value*	Post-test 40 days (n/%) n = 139			p – value*
	True	False	Not sure/No response	True	False	Not sure/No response		True	False	Not sure/No response	
1. To prevent the disease from worsening, you should prick your finger to check your blood sugar levels (T).	165 (92.18)	2 (1.12)	12 (6.70)	170 (94.97)	6 (3.35)	3 (1.68)	0.061	134 (96.40)	5 (3.60)	0	0.024
2. In diabetes, you should normally take the treatment prescribed by your doctor (T).	173 (96.65)	6 (3.35)	0	176 (98.32)	2 (1.12)	1 (0.56)	0.059	136 (97.84)	2 (1.44)	1 (0.72)	0.201
3. To prevent the disease from worsening, blood sugar levels should be close to normal values (V).	122 (68.16)	6 (3.35)	51 (28.49)	157 (87.71)	7 (3.91)	15 (8.38)	<0.001	119 (85.61)	4 (2.88)	16 (11.51)	<0.001
4. To prevent the disease from worsening, it is important to monitor your blood pressure (T).	94 (52.51)	18 (10.06)	67 (37.43)	122 (68.16)	33 (18.44)	24 (13.41)	<0.001	92 (66.19)	22 (15.83)	25 (17.99)	<0.001
5. Due to diabetes, other health problems can cause eye diseases (T).	103 (57.54)	12 (6.70)	64 (35.76)	134 (74.86)	21 (11.73)	24 (13.41)	<0.001	97 (69.78)	15 (10.79)	27 (19.42)	0.007
6. Due to diabetes, other health problems may arise without the diabetic person realizing it (T).	128 (71.51)	9 (5.03)	42 (23.46)	146 (81.56)	19 (10.61)	14 (7.82)	<0.001	113 (81.29)	5 (3.60)	21 (15.11)	0.029
7. In diabetes treatment, it is important to engage in daily physical activity, such as walking for approximately 20 minutes (T).	141 (78.77)	3 (1.68)	35 (19.55)	172 (96.09)	3 (1.68)	4 (2.23)	<0.001	127 (91.37)	5 (3.60)	7 (5.04)	<0.001
8. To prevent the disease from worsening, blood sugar levels must be very low (F).	52 (29.05)	71 (39.66)	56 (31.28)	58 (32.40)	108 (60.34)	13 (7.26)	<0.001	35 (25.18)	76 (54.68)	28 (20.14)	0.337
9. In the treatment of diabetes, a healthy diet is as important as the treatment prescribed by the doctor (T).	149 (83.24)	10 (5.59)	20 (11.17)	164 (91.62)	13 (7.26)	2 (1.12)	<0.001	117 (84.17)	9 (6.47)	13 (9.35)	0.259
10. Diabetes is a short-term disease (F).	4 (2.23)	154 (86.03)	21 (11.73)	11 (6.15)	156 (87.15)	12 (6.71)	0.008	126 (90.65)	4 (2.88)	9 (6.47)	0.144
11. Diabetes is a lifelong disease (T).	125 (69.83)	10 (5.59)	44 (24.58)	143 (79.89)	22 (12.29)	14 (7.82)	<0.001	113 (81.29)	9 (6.47)	17 (12.23)	0.004
12. Diabetes is a long-term disease (T).	142 (79.33)	8 (4.47)	29 (16.20)	164 (91.62)	13 (7.26)	2 (1.12)	<0.001	122 (87.77)	11 (7.91)	6 (4.32)	0.029
13. Diabetes is a disease that can be cured if the patient takes the medication prescribed by the doctor correctly (F).	16 (8.94)	111 (62.01)	52 (29.05)	33 (18.44)	135 (75.42)	11 (6.15)	<0.001	15 (10.79)	103 (74.10)	21 (15.11)	0.007
14. Diabetes is a disease that appears and disappears (F).	7 (3.91)	132 (73.74)	40 (22.35)	15 (8.38)	151 (84.36)	13 (7.27)	<0.001	10 (7.19)	111 (79.86)	18 (12.95)	0.005
15. Diabetes can be changed by low physical activity (F).	59 (32.96)	32 (17.88)	88 (49.16)	115 (64.25)	42 (23.46)	22 (12.29)	<0.001	62 (44.60)	46 (33.09)	31 (22.30)	<0.001
16. Diabetes is defined by having excessive sugar in the blood (T).	154 (86.03)	6 (3.35)	19 (10.61)	159 (88.83)	15 (8.38)	5 (2.79)	0.039	120 (86.33)	11 (7.91)	8 (5.76)	0.198
17. There is only one type of diabetes (F).	9 (5.03)	131 (73.18)	39 (21.79)	13 (7.26)	165 (92.18)	1 (0.56)	<0.001	6 (4.32)	130 (93.53)	3 (2.16)	<0.001
18. Type I diabetes is defined when the pancreas stops producing insulin and glucose accumulates in the blood (T).	79 (44.13)	9 (5.03)	91 (50.84)	164 (91.62)	8 (4.47)	7 (3.91)	<0.001	99 (71.22)	8 (5.76)	32 (23.02)	<0.001
19. Type I diabetes is more common in children, adolescents, and young adults (T).	95 (53.07)	13 (7.26)	71 (39.66)	170 (94.97)	3 (1.68)	6 (3.35)	<0.001	103 (74.10)	7 (5.04)	29 (20.86)	<0.001

* Marginal homogeneity test

Source: Prepared by the authors.

Table 3. Empowerment of Adolescent Students after the Educational Intervention with Comic Books (n = 179) and after 40 Days (n = 139). Vitória de Santo Antão, Pernambuco, Brazil, 2023

Evaluated factor	I totally disagree n (%)		I somewhat disagree n (%)		I neither agree nor disagree n (%)		I somewhat agree n (%)		I totally agree. n (%)		Mean (SD)		p – value*
	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	
1. What I learned today will help me adopt a stance and strengthen my opinions. (n = 173/n = 138)	7 (4.05)	7 (5.07)	8 (4.62)	9 (6.52)	22 (12.72)	37 (26.81)	41 (23.70)	37 926.81)	95 (54.91)	48 (34.78)	4.21 (1.1)	3.8 (1.14)	0.002
2. The class encouraged me to talk to other people. (n = 177/n = 136)	7 (3.95)	13 (9.56)	12 (6.78)	9 (6.62)	35 (19.77)	35 (25.74)	51 (28.81)	32 (23.53)	72 (40.68)	47 (34.56)	3.95 (1.11)	3.67 (1.28)	0.046
3. The class taught me to recognize my own needs. (n = 174/n = 135)	5 (2.87)	7 (5.19)	10 (5.75)	8 (5.93)	28 (16.09)	32 (23.70)	57 (32.76)	46 (34.07)	74 (42.53)	42 (31.11)	4.06 (1.04)	3.80 (1.10)	0.033
4. What I learned today will help me rethink my life plans. (n = 179/n = 137)	10 (5.59)	8 (5.84)	3 (1.68)	11 (8.03)	29 (16.20)	31 (22.63)	58 (32.40)	42 (30.66)	79 (44.13)	45 (32.85)	4.08 (1.08)	3.77 (1.16)	0.046
5. The class helped me to trust and believe in myself more. The class made me feel confident in myself. (n = 178/n = 136)	12 (6.74)	10 (7.35)	16 (8.99)	8 (5.88)	31 (17.42)	35 (25.74)	58 (32.58)	41 (30.15)	61 (34.27)	42 (30.88)	3.79 (1.20)	3.71 (1.18)	0.783
6. What I learned today will help me to be "myself". The class helped me to gain more control and become increasingly aware of my attitudes. (n = 175/n = 134)	8 (4.57)	11 (8.21)	6 (3.43)	9 (6.72)	30 (17.14)	34 (25.37)	48 (27.43)	36 (26.87)	83 (47.43)	44 (32.84)	4.1 (1.09)	3.69 (1.23)	0.007
7. Today was a day of new possibilities for learning about "being a teenager." I understood that there is no right way to be a teenager! Everyone has their own way of being a teenager! (n = 178/n = 139)	13 (7.30)	13 (9.35)	8 (4.49)	6 (4.32)	32 (17.98)	38 (27.34)	40 (22.47)	36 (25.90)	85 (47.75)	46 (33.09)	3.99 (1.23)	3.69 (1.24)	0.159
8. The class made me believe that I can think of my future, knowing what to do from now on. (n = 178/n = 135)	10 (5.62)	9 (6.67)	6 (3.37)	7 (5.19)	27 (15.17)	27 (20.00)	46 (25.84)	34 (25.19)	89 (50.00)	58 (42.96)	4.11 (1.13)	3.93 (1.20)	0.274
9. The class awakened me to not be an influenced teenager. (n = 171/n = 132)	16 (9.36)	10 (7.58)	11 (6.43)	6 (4.55)	36 (21.05)	38 (28.79)	40 (23.39)	32 (24.24)	68 (39.77)	46 (34.85)	3.78 (1.29)	3.74 (1.20)	0.834
10. After class, I will have a greater voice at school, in my family, and in society. (n = 171/n = 137)	16 (9.36)	14 (10.22)	12 (7.02)	11 (8.03)	46 (26.90)	53 (38.69)	44 (25.73)	33 (24.09)	53 (30.99)	26 (18.98)	3.62 (1.25)	3.34 (1.18)	0.274
11. What I learned today will help me socialize, meet new people, and make new friends. (n = 169/n = 138)	21 (12.43)	18 (13.04)	5 (2.96)	10 (7.25)	51 (30.18)	52 (37.68)	42 (24.85)	28 (20.29)	50 (29.59)	30 (21.74)	3.56 (1.29)	3.30 (1.26)	0.213
12. The class helped me learn how to deal with other people's opinions. (n = 168/n = 138)	17 (10.12)	18 (13.04)	14 (8.33)	8 (5.80)	36 (21.43)	39 (28.26)	44 (26.19)	44 (31.88)	57 (33.93)	29 (21.01)	3.65 (1.3)	3.42 (1.25)	0.442
13. After the class, I didn't feel the need to seek connections and support from healthcare professionals, family, and friends. (n = 170/n = 135)	69 (40.59)	47 (34.81)	24 (14.12)	20 (14.81)	37 (21.76)	40 (29.63)	20 (11.76)	13 (9.63)	20 (11.76)	15 (11.11)	2.40 (1.42)	2.47 (1.35)	0.715
14. With this class, I realized that I can contribute to improving the health of my colleagues, family, and community. (n = 170/n = 139)	2 (1.18)	3 (2.16)	12 (7.06)	3 (2.16)	20 (11.76)	36 (25.90)	46 (27.06)	38 (27.34)	90 (52.94)	59 (42.45)	4.24 (0.99)	4.06 (0.98)	0.185
15. In this class, I was able to understand that it is very important for us teenagers to participate more actively in school, in the community, and in the family. (n = 172/n = 136)	2 (1.16)	3 (2.21)	12 (6.98)	4 (2.94)	26 (15.12)	37 (27.21)	43 (25.00)	37 (27.21)	89 (51.74)	55 (40.44)	4.19 (1.01)	4.01 (1.00)	0.178 0.178
Individual empowerment mean											3.85 (0.46)	3.63 (0.39)	
16. The class helped me put myself in someone else's shoes, to respect and empathize with others. (n = 170/n = 138)	6 (3.53)	4 (2.90)	7 (4.12)	4 (2.90)	35 (20.59)	40 (28.99)	32 (18.82)	34 (24.64)	90 (52.94)	56 (40.58)	4.14 (1.1)	3.97 (1.04)	0.139

Evaluated factor	I totally disagree n (%)		I somewhat disagree n (%)		I neither agree nor disagree n (%)		I somewhat agree n (%)		I totally agree. n (%)		Mean (SD)		p – value*
	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	Immediate post-test	Post-test (40 days)	
17. In this class, I was able to realize that a democratic place is one where teenagers are heard, where choices are made together with teenagers. (n = 171/n = 137)	6 (3.51)	8 (5.84)	9 (5.26)	3 (2.19)	43 (25.15)	55 (40.15)	41 (23.98)	28 (20.44)	72 (42.11)	43 (31.39)	3.96 (1.1)	3.69 (1.11)	0.089
18. The class allowed me to recognize myself as a member of a school, family, friends, and/or community. (n = 170/n = 137)	6 (3.53)	7 (5.11)	7 (4.12)	10 (7.30)	46 (27.06)	38 (27.74)	47 (27.65)	37 (27.01)	64 (37.65)	45 (32.85)	3.92 (1.07)	3.75 (1.14)	0.123
19. The class encouraged me to become more engaged with the issues surrounding my school, family, and/or community. (n = 170/n = 138)	7 (4.12)	7 (5.07)	4 (2.35)	13 (9.42)	43 (25.29)	44 (31.88)	53 (31.18)	34 (24.64)	63 (37.06)	40 (28.99)	3.95 (1.05)	3.63 (1.15)	0.034
20. The class motivated me to help solve the health problems of my family, friends, and community. (n = 169/n = 137)	4 (2.37)	3 (2.19)	8 (4.73)	8 (5.84)	8 (4.73)	35 (25.55)	50 (29.59)	33 (24.09)	80 (47.34)	58 (42.34)	4.15 (1.01)	3.99 (1.06)	0.275
21. The class encouraged me to contribute to a more ethical, fair, and supportive society. (n = 168/n = 139)	8 (4.76)	11 (7.91)	4 (2.38)	12 (8.63)	46 (27.38)	33 (23.74)	42 (25.00)	37 (26.62)	68 (40.48)	46 (33.09)	3.94 (1.1)	3.68 (1.24)	0.049
22. In this class, I was challenged to pursue my rights as a citizen. (n = 171/n = 137)	13 (7.60)	13 (9.49)	12 (7.02)	11 (8.03)	46 (26.90)	41 (29.93)	38 (22.22)	29 (21.17)	62 (36.26)	43 (31.39)	3.73 (1.24)	3.57 (1.27)	0.187
23. The class neglected my background, my history, and my culture. (n = 169/n = 136)	56 (33.14)	47 (34.56)	11 (6.51)	7 (5.15)	53 (31.36)	43 (31.62)	20 (11.83)	19 (13.97)	29 (17.16)	20 (14.71)	2.73 (1.46)	2.69 (1.44)	0.630
24. After this class, I feel the need to change the environment in which I live. (n = 168/n = 138)	9 (5.36)	15 (10.87)	10 (5.95)	8 (5.80	44 (26.19)	42 (30.43)	45 (26.79)	42 (30.43)	60 (35.71)	31 (22.46)	3.82 (1.15)	3.48 (1.22)	0.093
25. After this class, I had the courage to suggest changes to the activities to suit the interests of the classroom. (n = 172/n = 136)	16 (9.30)	12 (8.82)	15 (8.72)	13 (9.56)	51 (29.65)	48 (35.29)	38 (22.09)	35 (25.74)	52 (30.23)	28 (20.59)	3.55 (1.26)	3.4 (1.18)	0.340
26. What I learned today will help me understand the world in a different way. (n = 166/n = 136)	2 (1.20)	7 (5.15)	4 (2.41)	10 (7.35)	39 (23.49)	36 (26.47)	39 (23.49)	37 (26.47)	82 (49.40)	46 (33.82)	4.17 (0.95)	3.77 (1.15)	0.009
27. In this class, I was able to realize that social inequality exists and in many places. (n = 170/n = 136)	14 (8.24)	11 (8.09)	12 (7.06)	11 (8.09)	44 (25.88)	39 (28.68)	48 (28.24)	37 (27.21)	52 (30.59)	38 (27.94)	3.66 (1.22)	3.59 (1.21)	0.923
28. In this class, I was able to realize that a teenager is at risk when they do not receive the necessary protection for their growth and development, such as healthcare, food, education, and many other things. (n = 169/n = 138)	7 (4.14)	7 (5.07)	6 (3.55)	13 (9.42)	40 (23.67)	41 (29.71)	45 (26.63)	25 (18.12)	71 (42.01)	52 (37.68)	3.99 (1.09)	3.74 (1.20)	0.142
29. The class gave me a feeling of freedom. (n = 171/n = 137)	8 (4.68)	11 (8.03)	12 (7.02)	14 (10.22)	47 (27.49)	41 (29.93)	39 (22.81)	35 (25.55)	65 (38.01)	36 (26.28)	3.82 (1.15)	3.52 (1.21)	0.013
30. The class showed me reality, practice, and how things happen out there. (n = 173/n = 137)	2 (1.16)	4 (2.92)	8 (4.62)	12 (8.76)	33 (19.08)	29 (21.17)	42 (24.28)	38 (27.74)	88 (50.87)	54 (39.42)	4.19 (0.98)	3.92 (1.11)	0.088
31. The class motivated me to resolve conflicts in a nonviolent way, through dialogue and solidarity. (n = 172/n = 139)	11 (6.40)	15 (10.79)	4 (2.33)	13 (9.35)	44 (25.58)	43(30.94)	29 (16.86)	27 (19.42)	84 (48.84)	41 (29.50)	3.99 (1.19)	3.47 (1.3)	<0.001
Social class empowerment mean											3.86 (0.35)	3.62 (0.30)	

*Wilcoxon nonparametric test.

Source: Prepared by the authors.

It was also found that before the health education intervention was implemented, during the pre-test (Table 2), most of the adolescent students had doubts regarding items related to the definition of T1DM, the most affected population class, control, causes, complications, and duration. It is evident that the use of active methodologies for acquiring knowledge regarding T1DM with comic books was effective, since significant changes in the knowledge of the adolescent students regarding T1DM were noted at the time of the immediate post-test. When evaluated later (40-day post-test), the adolescents were able to retain their knowledge on most items. In raising this issue, authors corroborate the findings by recognizing that health education measures generate knowledge and empower groups and/or communities on various themes (1, 17, 19, 20).

Similarly, in an analysis conducted with 43 students from public schools, which evaluated the structured educational intervention program for metabolic syndrome in Picos (Piauí), consisting of five health education meetings, in which this syndrome (definition and contextualization) and risk factors such as abdominal obesity, high blood pressure, high blood sugar, low HDL cholesterol, and high triglyceride levels were discussed. In addition, issues such as physical inactivity, physical activity, healthy diet, alcoholism, and smoking were addressed. It was found that almost half of the students had a low level of knowledge regarding metabolic syndrome before the interventions were implemented. However, after the health education sessions (immediate post-test), the number of students with low knowledge decreased significantly. In the delayed post-test (90 days later), although the mean test score decreased compared to that assessed immediately after health education, students retained a higher level of knowledge than those analyzed in the pre-test (17).

These findings proved to be important for the positive effects of educational health interventions, through the use of active methodologies that promote the principles of popular health education, as well as contributing to the knowledge of these adolescents as determinants for healthy practices.

In this study, the application of EJEduS was also evaluated, in which the empowerment of adolescent students was observed after the educational intervention on T1DM with comic books. In addition, the responses from the immediate post-test and the 40-day post-test were compared, leading to the finding that, of the 31 items on the scale, there was statistical significance in only 10 questions of the factors evaluated: items 1, 2, 3, 4, and 6 (individual empowerment) and 19, 21, 26, 29, and 31 (social class empowerment). The use of comic books as an educational technology in health is effective and can be considered a facilitator in the communication and dissemination of relevant topics in various areas of focus (21). Although it was effective in increasing knowledge, it did not show satisfactory results in encouraging both individual and social class empowerment among participants.

Therefore, the importance of implementing educational strategies that enable dialogue in the construction of knowledge is confirmed, as this can help vulnerable or at-risk adolescents to change their behavior, promoting autonomy and co-participation in decision-making regarding their health, as well as enabling them to become agents of change for themselves and their community. Through the development of skills and the acquisition of knowledge, the individual's abilities and capacities are strengthened, thereby leading to empowerment, which can be defined as the process whereby people are in situations that can alter the effect of their perception of control over their own choices (16, 17, 22).

One way to encourage this empowerment is through the implementation of intersectoral strategies, particularly in education, as a means of interacting with the community and sharing knowledge regarding healthcare (23). In light of this, one of the processes would be for healthcare professionals to develop educational activities in public schools, which are conducive spaces for learning and raising awareness regarding the adoption of healthy habits among children and adolescents. Thus, they become multipliers of information among all those around them, encouraging them to be healthier and seek a better quality of life (22, 24).

When dealing with adolescents, it is important to consider the particularities of this stage of development and that they are in the process of critical-reflective thinking regarding various aspects, including issues surrounding health, disease control, and prevention.

Therefore, it should be highlighted that schools are spaces for promoting health, fields for stimulating dialogue and discussions on issues that surround and challenge society, so that they can build knowledge that concretely provides health and well-being for adolescents. Educational practices, meanwhile, can empower children and adolescents and should be listed as priorities for schools in their political-pedagogical projects, thereby contributing to leadership stances and recognition of social and health determinants (1, 24).

Conclusion

It was found that there was a significant increase in the knowledge of adolescent students who participated in the educational health intervention with comic books regarding T1DM, from the pre-test to the immediate post-test. Regarding the pre-test and the 40-day post-test, it was evident that knowledge acquisition was retained in most items.

The low statistical significance regarding adolescent empowerment may demonstrate the need for the educational intervention to be approached in a more horizontal and active manner to enable measures that promote dialogue and empowerment.

Health education technology as an active methodology emerges as a potential tool to assist teaching in a student-centered education scenario, helping students to prevent disease and damage to their health, as well as enabling them to become multipliers and increasing this audience's adherence to healthcare services.

In this sense, educational interventions, when targeted accurately, stimulate the process of empowerment and liberation, creating environments conducive to the development of critical and conscious thinking. Understanding healthcare also in its educational dimension is essential to establishing a path of transformation and emancipation, supporting individuals to make responsible choices consistent with the type of life they have chosen to favor.

Aiming to restore the educational value of comic books and promote active methodologies in a playful way for health literacy, which also empower adolescents on an individual and social level, the results of this study may equip and encourage healthcare professionals to act effectively in health education. Such action will contribute to controlling diabetes and its complications, as well as improving adolescents' quality of life.

Finally, it is possible to state that, beyond implementation, the continuity of educational interventions in the school environment is essential for the development of critical-reflective thinking capable of transforming the context of vulnerability and high-risk behaviors among adolescent students, rather than merely memorizing concepts and guidelines. Furthermore, it is necessary to promote the development of awareness, autonomy, self-care, and the adoption of positive health practices.

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