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Co-design of an animated resource to understand inequities in access to diabetes technologies among children and young people with type 1 diabetes from ethnic minority groups and/or low socioeconomic areas

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ABSTRACT

Aims: This study aimed to explore barriers to diabetes technology access and co-create an educational animation to address them.
Methods: Guided by a community-based participatory research (CBPR) approach and the Generative Co-Design Framework for Healthcare Innovation, the study followed three stages: Pre-Design, Co-Design, and Post-Design. It built on prior qualitative research and was shaped by input from an advisory panel. Co-design workshops informed the animation's content and style. A total of 16 participants were involved: 6 (2 parents, 4 young people) contributed to advisory sessions, and 10 (5 parents, 5 children and young people) participated in co-design workshops. Data were analysed using reflexive thematic analysis.
Results: Key barriers included misconceptions about cost, limited awareness of NHS-funded technologies, and emotional and financial burdens. Participants emphasised the importance of diverse representation, accessible language, and engaging visuals to ensure the animation resonated with a wide audience, including healthcare professionals, families, educators, and policymakers. Post-design evaluation confirmed its usability.
Conclusions: Guided by collaborative principles, the co-designed animation is a valuable tool for raising awareness and promoting equitable access to diabetes technology. Future research should explore broader implementation and standardisation of such educational tools across NHS services.

1. Introduction

Type 1 Diabetes (T1D) is a lifelong condition that requires continuous management through blood glucose monitoring and insulin therapy [1]. Advancements in diabetes technologies such as continuous glucose monitoring (CGM) and insulin pumps have significantly improved health outcomes by reducing HbA1c levels, preventing hypoglycaemia, and enhancing quality of life [2,3]. National and international organisations consistently recommend the use of these technologies to improve clinical outcomes [4,5]. The updated NICE Technology Appraisal (TA943) further reinforces this, advocating for widespread NHS implementation and access to diabetes technologies for children and young people (CYP) with T1D [5].

Despite these recommendations, persistent inequities remain. Socioeconomic status, ethnicity, and regional variations in healthcare commissioning contribute to lower uptake of these life-changing technologies among CYP from disadvantaged backgrounds and ethnic minority groups [6–10]. The 2022/2023 National Paediatric Diabetes Audit (NPDA) report had already highlighted growing disparities in access across the UK, particularly between the most and least deprived areas and between white and ethnic minority CYP [9].

Yet, despite these earlier warnings, the latest 2025 NPDA report confirms that these disparities persist [10]. According to the 2025 data, the mean HbA1c for Black CYP with T1D increased from 70.0 mmol/mol

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in 2022/23 to 71.0 mmol/mol in 2023/24, remaining substantially higher than the 63.0 mmol/mol observed in White CYP [10]. The HbA1c gap between the most and least deprived quintiles also remains, with averages of 66.0 and 60.0 mmol/mol respectively in 2023/24—virtually unchanged from 66.8 to 59.9 mmol/mol the previous year. Moreover, the 2025 NPDA underscores that uptake of diabetes technologies, including real-time continuous glucose monitoring (rtCGM), insulin pumps, and Hybrid Closed Loop systems, continues to be significantly lower among ethnic minority groups and those living in socioeconomically deprived areas [10].

Initial findings from our qualitative study explored the barriers faced by CYP from ethnic minority backgrounds and/or low socioeconomic areas in accessing diabetes technologies and identified potential strategies to promote equitable improvements [11]. The study involves 32 participants, comprising 27 triad interviews involving parents and CYP, along with an additional five triad interviews led by young people. Findings identified multiple, intersecting barriers to diabetes technology access, including systemic inequities, cultural and linguistic challenges, and financial constraints. These results highlight the urgent need for targeted and contextually appropriate interventions to ensure more equitable access to diabetes care.

Given the significant barriers identified in our qualitative study, a co-design approach was deemed essential to develop an intervention that directly reflects the lived experiences of CYP from ethnic minority backgrounds and/or low socioeconomic areas. Co-design has been particularly effective in diabetes care contexts, with evidence showing how participatory methods can enhance digital education and self-management tools for young people living with type 1 diabetes [12]. Additional research has shown the co-design model can be useful in the development of educational support interventions and decision making for people with type 1 with diabetes [13,14].

Beyond ensuring relevance, integrating participant engagement throughout the planning, implementation, and dissemination phases fosters a more inclusive and ethical approach, shifting from "ethical by design" to truly "equitable by design" [15]. This perspective aligns with community-based participatory research (CBPR), which redefines traditional researcher-participant dynamics by promoting shared decision-making and addressing community priorities [16]. A co-design approach has been increasingly recognized as an effective method for developing health interventions, particularly in addressing health inequities [12,13]. By actively involving end-users in the development process, co-design ensures that interventions are more relevant, accessible, and aligned with the needs of the target population [12,15]. Moreover, the increasing involvement of patient and wider partners in health research highlights the importance of participatory methods not only in designing healthcare interventions but also in shaping healthcare systems and services [17]. These approaches can enhance not just patient experience but also broader quality, including accessibility and validity. Traditionally, healthcare improvements have been driven by efficiency and cost-effectiveness outcomes that are easier to measure, often overlooking equity, inclusivity, and diversity. Embedding co-design principles in health innovation ensures that interventions address systemic disparities and reflect the needs of those most affected, fostering sustainable and meaningful change [12].

Building on these insights, this study aimed to co-design an animated resource that raises awareness of CYP's lived experiences and highlight their recommendations for equitable improvements [18]. Animated storytelling was selected for its engaging and accessible format, suitable for children and families of all ages and socioeconomic backgrounds. Participants from our earlier study both CYP and parents recommended animation as the best way to share information, especially on social media. Through a participatory approach, we engaged CYP in shaping the animation's content, ensuring that it effectively communicated key messages and resonated with the communities most affected by disparities in diabetes technology access.

2. Methods

The study employed a CBPR approach [16], guided by the Generative Co-Design Framework for Healthcare Innovation [19]. This ensured that the intervention was developed in close collaboration with young people and caregivers, reflecting both research evidence and lived experiences. The co-design process followed three key stages: Pre-Design, Co-Design, and Post-Design, see Fig. 1. Each stage played a crucial role in integrating user insights, research findings, and creative elements to produce an accessible and meaningful resource.

This qualitative exploratory study was reviewed and approved by the University of Leicester Research Ethics Committee and the Health Research Authority (REC 23/WS/0095). All research participants provided written informed consent including for anonymized information to be published in this article.

2.1. Pre-design

The pre-design stage involved the establishment of a Young People's Advisory Group (YPAG), consisting of young adults aged 18–25 years with T1D and/or parent representatives. The YPAG provided ongoing advisory input throughout the study, ensuring that the perspectives of young adults with lived experience informed the research design, interpretation of findings, and development of the animated resource.

The group met four times a year via online platforms such as Zoom or Microsoft Teams, with each session lasting between one to 2 h. In addition to advising on the research process, the members provided recommendations on how the study findings including the animated resource should be disseminated at individual, organizational, and policy levels. They also played an active role in shaping the animation.

To further inform the co-design process, we conducted a formative research phase that included qualitative interviews with children and young people with T1D, findings from which were reported in our recent publication [11]. This was informed by a focused search of relevant literature and policies in the UK, supplemented by advisory discussions with experts, including project team members The purpose of was to identify existing needs, methodological considerations, and gaps in data collection and reporting, as well as to explore potential solutions to improve the accessibility of diabetes technologies through the animation.

In preparation for the co-design sessions, weekly meetings were held between the research team and an animation company (Nitty Fox), to review findings and finalize the design plan. These meetings allowed for continuous refinement of the approach, ensuring that the animation remained aligned with the needs and experiences of young people with T1D.

2.2. Co-design

The co-design phase followed a structured three-step process, conducted in collaboration with the animation company (Nitty Fox). The first step focused on developing an outline script and storyboard, which defined the content and key messages of the animated video. This process was iterative and shaped by insights gathered during the pre-design phase, ensuring that the animation authentically reflected the lived experiences and challenges faced by young people with Type 1 Diabetes (T1D).

After the initial content development, we held two interactive co-design workshops with young adults living with T1D and parent representatives. CYPs aged 15–17 years living with type 1 diabetes (T1D), and/or their parents, from ethnic minority backgrounds or socioeconomically disadvantaged areas were included in the co-design workshops.

Participants were recruited through NHS sites and social media to ensure diverse perspectives. These workshops provided a space for participants to share their personal experiences with diabetes

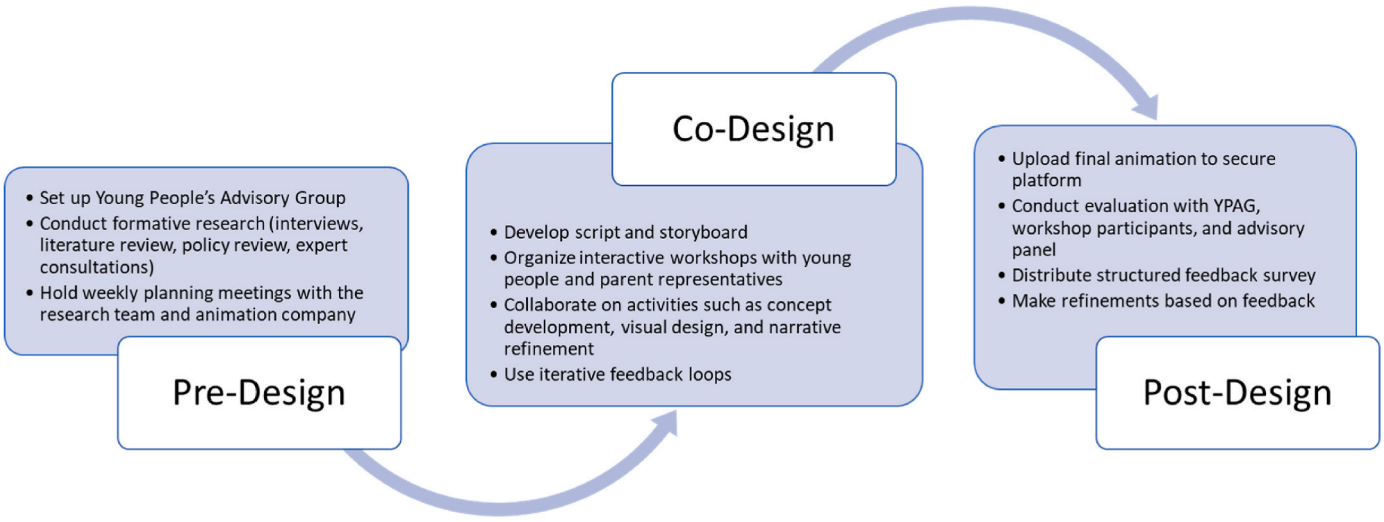

Fig. 1. Co-design Process
Adapted from Clabourn et al. (2022).

management and the barriers they faced in accessing diabetes technologies.

During the workshops, participants engaged in collaborative activities, including visual concept development, storyboard refinement, and infographic sketching. These activities allowed participants to shape the design of the animation, ensuring it was both engaging and representative of their experiences. The workshops were conducted virtually via Microsoft Teams.h Each session was facilitated by a representative from the animation company, with members of the research team present to provide support, and all sessions were recorded. Workshops lasted approximately 1.5 h. As part of the co-design process, participants contributed to the development of a central animated character, Aisha, whose storyline was used to reflect the lived experiences and challenges of accessing diabetes technologies among children and young people with T1D.

To capture the depth of participant contributions, discussions were audio-recorded, transcribed verbatim, and supplemented with field notes. This data was then used to refine the animation, ensuring that the final product was co-created and driven by user input.

The two workshops not only provided an opportunity for participants to share their challenges but also directly influenced the animation's content, tone, and visual style.

Participants were recruited through NHS paediatric diabetes clinics and community outreach via diabetes advocacy networks and social media. Participants were selected using purposive sampling based to the study. Participants were recruited via email and received an information sheet outlining the study. Informed consent was obtained electronically through a reply email.

The sample size was not rigidly predetermined but was guided by the aim to capture diverse perspectives by including both CYP and parents. In line with typical qualitative focus group studies, which usually involve 5–8 participants, we intentionally limited the number of participants to fewer than 10 to ensure active engagement and meaningful contribution during the workshops. Given the participatory and creative nature of the co-design framework, this smaller group size facilitated productive interaction.

All participants were users of diabetes technologies, representing a range of devices from basic to more advanced systems. Their levels of access and experience with these technologies varied, reflecting diverse real-world usage and accessibility barriers. They received modest gift vouchers (£25) to acknowledge their time and contributions in line with NIHR guidance on recognising public involvement in research [20].

The co-design workshops were led by an independent facilitator from an external animation and design company (Ninety Fox). Members of the research team (ND and ET) attended the workshops and provided support where needed but did not lead facilitation.

They were women and represent diverse ethnicities ND (PhD) identifies as Mixed Black-African, and ET (PhD) identifies as White Turkish and did not have any prior clinical relationship or direct familiarity with them. Wider team members leading and co-leading the study are clinicians (MD), clinical scientists and clinic academics, MN is a clinical academic and Consultant Paediatric Endocrinologist, ME is a clinical scientist and consultant working in diabetes and general medicine, and NO is clinical academic and consultant diabetologist. The animation company (Nitty Fox) involved was external to the research team and the facilitator has a background as social science researcher and has extensive experience in NHS-related research and patient and public involvement.

2.3. Post-Design

The final stage of the co-design process focused on evaluation and refinement. The completed animation was uploaded to Vimeo, a secure video-sharing platform, and shared with YPAG members, workshop participants for review. A brief structured feedback form was distributed to YPAG members, and workshop participants. The form included a simple overall rating of the animation (ranging from 'poor' to 'excellent') and open-ended questions inviting comments on key aspects such as script, clarity, storyline, characters, and areas for improvement. All respondents rated the animation and provided qualitative comments that were thematically summarised (e.g., appreciation of the character "Aisha," perceived relevance to inequities in access, and suggestions for broader representation and future work). The purpose of this stage was formative refinement rather than formal evaluation.

By ensuring that the co-design process extended beyond content creation to include evaluation and refinement, the study produced an intervention that was not only research-informed but also community-driven and accessible to a broad audience.

2.4. Data analysis

Thematic reflexive analysis was used to analyse the data. A researcher with expertise in qualitative methods initially coded the transcripts, developing an analytic framework based on emerging themes with QSR NVivo 12 software. The framework was iteratively refined as new codes emerged, ensuring a comprehensive and nuanced

interpretation of the data. To ensure a rigorous and trustworthy interpretation of the data, an additional researcher reviewed and engaged with the coding and developing themes, with discussions undertaken to deepen interpretation and analytic insight. Discrepancies were resolved through discussion between the research team, and coding and theme development were discussed collaboratively to deepen interpretation rather than to achieve consensus. Triangulation of field notes, transcripts, and participant contributions further strengthened the analysis [21].

To further ensure trustworthiness, the analysis was guided by the four criteria of qualitative rigor: credibility, dependability, confirmability, and transferability. These were supported through maintaining a detailed audit trail of coding decisions, conducting peer debriefing, and engaging in ongoing reflexive discussions within the research team. Member-checking was also carried out with selected participants to enhance the credibility and resonance of the findings. The major themes are presented narratively and illustrated with direct quotes from participants.

Consistent with a reflexive thematic analysis, themes were generated through an active and interpretive process rather than treated as inherent within the data. Interpretation was shaped by the researchers' disciplinary backgrounds, prior qualitative work in this area, and positioning in relation to health inequalities. Reflexive discussions were undertaken throughout the analytic process to critically examine assumptions, analytic decisions, and the influence of prior study findings on theme development.

Data saturation was not formally assessed, as this study used a co-design workshop methodology focused on iterative generation and refinement of ideas rather than sequential qualitative sampling aimed at thematic saturation.

3. Results

A total of 6 participants, including 2 parents and 4 young people, attended the young people's advisory/consultation panel meetings. Ten participants, consisting of 5 parents and 5 children and young people, participated in the co-design workshops. Children and young people and parents participating in the study were not from the same families. Please see Table 1 below that shows the characteristics of participants for the YPAG and Co-design workshops. However, participants shared the prototype animation and sketches with their own children or parents, if applicable, and we received additional comments and feedback from them. The findings are reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist for qualitative focus groups. No instances of non-participation or withdrawal were recorded following consent, as all recruited participants attended and contributed to the workshops.

Table 1
Characteristics of participants for the YPAG and Co-design workshops.

	YPAG (Young People's Advisory Group)	Co-design workshops
Sample size	6	10
Participant type	Young adults with Type 1 Diabetes and/or parents	CYP with T1D and/or parent representatives
Age range	Young adults: 18–25 years Parents: Not collected	CYPs: 15–17 years Parents: 24 -35 years
Gender	2 female, 2 male young adult 2 female parents	2 male parents. 1 female parent. 4 CYP females. 3 CYP males.
Role in study	Consultative and strategic input	Experiential and design input (diabetes technology experiences, animation content and design)

3.1. Pre-design

3.1.1. Advisory group insights

The advisory group and co-design workshop provided valuable insights into the development of an animation aimed at raising awareness about diabetes health technology. The feedback gathered in these sessions highlighted key themes related to participants' experiences with diabetes technology and the barriers to access, as well as suggestions for improving user engagement and inclusivity.

The advisory group, consisting of six participants, discussed the importance of including personal experiences in shaping the project's direction. One participant shared their long-standing involvement in the National Diabetes Network and Families with Diabetes Network, emphasizing the need for community support and advocacy. These experiences played a key role in reinforcing the importance of family connections and peer support in the co-design process.

The group also stressed the significance of understanding the challenges faced by families affected by diabetes, particularly in accessing technology. It was noted that socio-economic factors, such as low income, could limit access to diabetes management tools, a point that was reinforced during the co-design workshop.

3.1.2. Previous research and review of policies

Policy Summary: The recently updated NICE Technology Appraisal (TA943) represents a crucial step toward reducing disparities in diabetes care. It expands eligibility criteria and recommends the widespread NHS adoption of hybrid closed-loop systems for children and adolescents with Type 1 Diabetes (T1D). As a result, these technologies should be freely available to all eligible children through the NHS, ensuring equitable access regardless of socioeconomic background.

Research Findings: Our previous research, which involved interviews with children and young people (CYP), highlighted persistent inequities in accessing diabetes technologies, particularly among those from ethnic minority backgrounds and low socioeconomic communities. Despite these technologies being freely available through the NHS, many CYP and their families remain unaware of their entitlement. This lack of awareness, compounded by financial constraints, cultural and linguistic barriers, systemic healthcare biases, and geographic disparities, continues to hinder equitable access. Additionally, challenges related to the affordability of connected devices, inconsistencies in education and support systems, and variations in healthcare settings further exacerbate these barriers.

Next Steps: To address these issues, we planned to bring this discussion to our co-design workshops, where we will explore the root causes of these access barriers and identify actionable solutions.

3.2. Co-design

3.2.1. Co-design workshops 1 and 2

The co-design workshops included 10 participants who shared their experiences with diabetes technology and provided feedback on the animation project. In the first workshop, three parents attended with their children and young people (CYP), along with two young people attending independently. The second workshop included five young people. Half of the participants were from African-Caribbean backgrounds, while the others were from African and Asian backgrounds. Parents were aged 24 to 35, and young people were between 15 and 17 years old. Their input highlighted both the benefits and challenges of diabetes technology, as well as suggestions to improve its functionality and accessibility.

The key themes that emerged: Target Audience, Positive Experience of Technology, Negative Experiences/Barriers, and Visual and Technical Animation Design Feedback. The themes and scripts developed from these discussions informed the animation design. Fig. 2 presents the target audience script, while Fig. 3 illustrates barriers to technology access.

Fig. 2. Target audience.

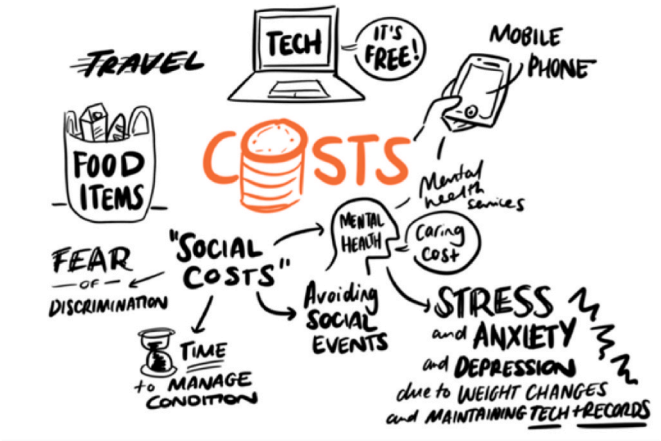

Fig. 3. Costs of managing diabetes extend beyond financial aspects.

3.2.2. Theme 1: target audience

Through brainstorming and discussion, participants identified several key target audiences for the animation. These included healthcare professionals, parents, teachers, young people, other patients, technicians, registered dietitians, and policymakers. Emphasis was placed on addressing the specific challenges faced by each group to improve the understanding and usage of diabetes health technology. The following scripts were developed during the workshop, with input from participants (see Fig. 2).

3.2.3. Theme 2: Positive Experiences of technology

3.2.3.1. Convenience and accuracy. Participants reported that diabetes technology has made monitoring glucose levels more convenient and accurate, which helped them manage their condition more effectively. Some also noted that smart insulin systems had eased the burden of constant monitoring, improving their overall quality of life. The connection with healthcare providers was highlighted as a positive aspect, as it allowed for easier communication and more coordinated care.

> *"It's really easy when you've got the help of your mum, and it has accurate readings."* (16-year-old Black African Caribbean male)

> *"We've also got smart insulin … it can help with management."* (17-year-old Asian male)

3.2.3.2. Improved communication with healthcare providers. Some participants found that the technology facilitated better communication with their healthcare providers. It allowed for more efficient and coordinated care, as it enabled easy updates and consultations, ultimately enhancing their overall management experience.

> *"It's created a more convenient communication and travel channel with your provider."* (34-year-old Black African parent, with 16-year-old child)

> *"Having more coordinated care, easier communication … that's been really positive."* (34-year-old black African parent, with 16-year- old child)

3.2.4. Community support

Participants mentioned that interacting with other people who use similar technologies helped them shape their perspectives and gain valuable insights. Learning from others' experiences fostered a sense of community and provided educational opportunities for better managing diabetes.

> *"Coming across other people's experiences has helped you shape your perspective."(35- year- old Black African parent)*

3.2.5. Theme 3: Negative Experiences/Barriers

3.2.5.1. Costs and mental burden of managing diabetes. Participants discussed the high costs of diabetes technology, particularly for advanced tools like CGMs. They also highlighted that the costs of managing diabetes extend beyond financial aspects, including the expenses related to connected technology, the time spent managing health, travel for appointments, and the mental health challenges compounded by the fear of discrimination (See Fig. 3)

> *"The cost of managing diabetes isn't just about money; it's also about time and emotional strain. It affects your mental health, and as a parent, it adds another layer of responsibility." "* (35-year-old Black African parent with 16-year-old child)

> *"Managing the device and medication records is overwhelming, and there's a lot of stress about keeping everything accurate."* (24-year-old, Black African-Caribbean parent with 4-year-old child)

> *"The emotional cost, like anxiety and weight gain, really adds to the overall burden."* (24-year-old, Black African Caribbean parent with 4-year-old child)

3.2.5.2. Diabetes technologies: technical problems. Participants expressed frustration with the complexity of diabetes technology, particularly apps and devices that require significant training to use effectively. Technical issues, such as connectivity problems and syncing issues, were also common complaints. These problems could disrupt the monitoring process, leading to uncertainty about the accuracy of readings and creating stress for users.

> *"There's lots of times when it doesn't work, and you're not sure why."* (17-year-old Asian male)

> "Connectivity problems … that's definitely a challenge."(17-year-old Asian male)

3.2.5.3. Suggestions for improvement. Participants highlighted the need for more comprehensive training and support to help users better understand how to operate devices and troubleshoot common issues. They also suggested that the animation should address key concerns, including reducing device discomfort, improving connectivity, and advocating for more affordable options. Importantly, participants stressed the value of authentic representation and expressed a desire to contribute directly, some even volunteered to provide the voiceover themselves. Fig. 4 illustrates the animation's storyline. Additional scripts, including those suggestions and design outputs by participants, as well as a non-animated visual sketch/poster, are available in Supplementary File 1.

3.2.6. Theme 4: Visual and Technical Animation Design Feedback

Participants provided feedback on the animation's visual and technical elements (see in supplementary file 1), emphasizing the importance of an engaging, relatable, and inclusive design. Their reflections shaped the animation's overall tone, character representation, and accessibility.

3.2.6.1. Colour scheme and character design. Many participants felt that the **colour scheme** should create a sense of positivity and energy, particularly for younger viewers. Bright tones such as blues, greens, yellows, and oranges were recommended to reflect hope and optimism in managing diabetes.

In terms of **character design**, participants strongly advocated for representations that were both culturally diverse and relatable. Characters needed to reflect the daily realities of young people using diabetes technology, while also conveying vibrancy and confidence. One parent explained:

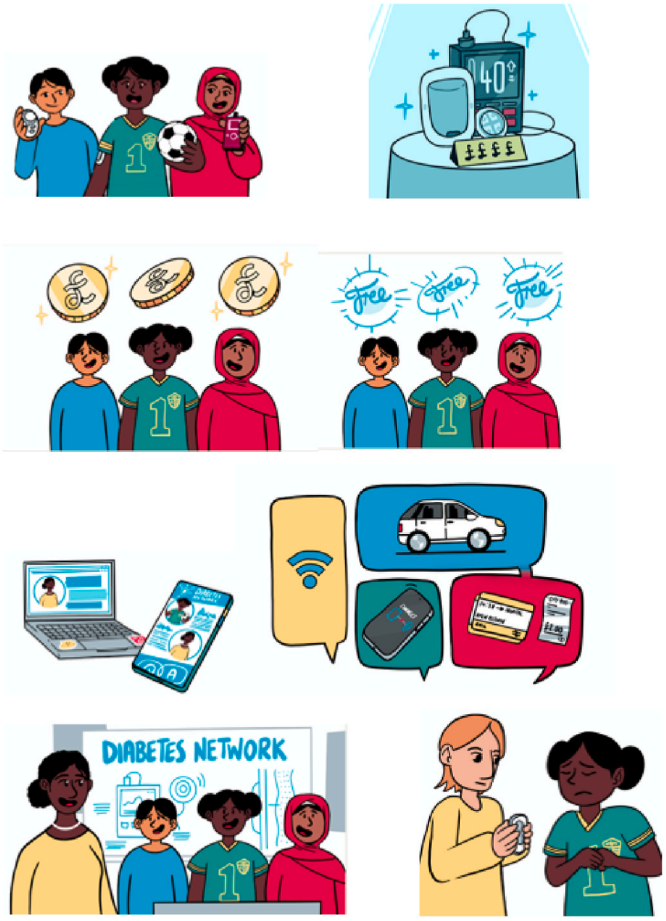

Fig. 4. Visual representation of the storyline.

"We need characters that look happy and energetic, and they should be using the technology that we use every day, like glucose pumps." (35-year-old Black African parent with 16-year-old child)

3.2.6.2. Voiceover and language. The use of **voiceover and language** also featured prominently in discussions. Participants stressed the importance of simplicity, warmth, and approachability in tone. The voiceover needed to avoid technical jargon and speak directly to families unfamiliar with diabetes care. As one participant put it:

"I think the voiceover should be clear and not too technical. Keep it simple so everyone can understand." (24-year-old Black African Caribbean parent with 4-year-old child)

Young people also expressed the importance of the accent or dialect used in the animation reflecting their own lived experiences. They raised concerns about being misunderstood by healthcare professionals. One young participant shared:

"I want the video to represent us – how we speak and how we try to navigate our tech access." (16-year-old Black African female)

3.2.6.3. Interactive learning. Several participants also raised ideas around **interactive learning**, suggesting that companion materialssuch as quizzes or gamescould be used alongside the animation to enhance understanding of diabetes technologies. This was particularly seen as helpful for children and young people navigating new information. One parent noted:

"I love the idea of making a video interactive- to support understanding on the tech. Maybe add some quizzes or games to make it more engaging." (35-year-old Black African parent with 16-year-old child)

3.2.6.4. Tone and inclusivity. Finally, participants emphasised the need to keep the overall tone of the animation non-clinical and inclusive. They wanted to ensure that the video did not feel overly technical or intimidating, particularly for those with limited prior knowledge of diabetes management. As one parent shared:

"We need to make sure that the animation is accessible to everyone and doesn't feel too technical. It should make it easier to understand diabetes management." (24-year-old Black African Caribbean parent with 4-year-old child)

This feedback informed both the aesthetic and educational design of the animation, ensuring it remains grounded in the needs and preferences of those it was created to serve.

3.2.6.5. Advisory group and the co-design workshop take home messages. The feedback from both the advisory group and the co-design workshop provided invaluable insights into the challenges and needs of families managing diabetes. Key themes such as the need for improved awareness, better access to technology, and financial barriers were prevalent throughout the discussions. These insights guided the development of the animation, ensuring it addresses the real-world challenges faced by those living with diabetes, particularly in underserved communities. Participants stressed the importance of making the animation interactive, suggesting the inclusion of games and quizzes to engage younger audiences and promote active learning. Inclusivity and diversity were highlighted as essential components in the animation design, with a focus on representing a wide range of backgrounds and experiences.

3.3. Post-Design

The feedback on the video was generally positive, with respondents describing it as an effective way to highlight the importance of accessing diabetes technologies, particularly for children and young people from

ethnic minority or low-income backgrounds. Participants appreciated how the character Aisha represented the challenges ethnic minorities face in accessing diabetes technologies across the UK. Her storyline resonated with viewers and was seen as crucial in raising awareness.

Respondents suggested incorporating more diverse perspectives and experiences, including the challenges faced by different ethnic minority groups and those living in remote areas. They also recommended funding further projects to explore and address accessibility barriers in these areas, ensuring equitable access to diabetes technologies for all individuals, regardless of background or location.

Based on this feedback, the animation was revised in collaboration with workshop participants, the advisory group, and the research team. The final version of the co-designed animation can be accessed here: https://www.dropbox.com/scl/fo/u91qph46gk3mivlfyqt5h/AIGljE59l5cGJY7e1dtnlg4?e=4&preview=Unbiased_Subtitled+.mp4&rlkey=tq9bubz86fkxwlgafjhkny9em&dl=0 [22].

4. Discussion

Managing health with T1D is challenging without diabetes technology, yet many children and young people, and their families, lack clear information about available devices and how to access them. Discussions revealed a common misconception that diabetes technology requires payment, despite being free, leading participants to stress the importance of addressing this in the animation. They emphasised the need to tailor content for various audiences, including parents, teachers, young people, healthcare professionals, and policymakers, to improve understanding of access barriers. Participants noted that technology enhances communication and care coordination, while connecting with others who use similar devices provides valuable insights. They also highlighted that the costs of managing diabetes extend beyond finances, including expenses for connected technology, time spent on self-management, travel for appointments, and mental health burdens such as the fear of discrimination. Participants highlighted the need for a stronger Diabetes Network and engaging educational resources to improve awareness and accessibility. These considerations and suggestions were integrated into the animation's storyline and script. Their feedback also guided refinements in character illustrations, storytelling, and messaging, ensuring the animated resource effectively addresses these inequities.

Our study employed a co-design approach, ensuring that children and young people (CYP) with type 1 diabetes (T1D) actively contributed at every stage of the design process [19]. By prioritizing their lived experiences rather than relying solely on researcher or clinician perspectives, we developed an animation that authentically represents the challenges of accessing diabetes technologies in their own language, and/or accent and dialect. This aligns with the principles of the generative co-design framework for healthcare innovation, which emphasizes deep end-user engagement to create solutions that are not only relevant but also actionable [19].

While we initially anticipated that online workshops might limit participant engagement, feedback indicated that the virtual format facilitated accessibility and flexibility, making the design process more inclusive. However, we recognize that face-to-face workshops could enhance interaction and co-creation dynamics, representing a potential limitation of our study.

The key themes that emerged from our focus group discussions closely mirrored findings from our previous qualitative research on technology accessibility [11]. The most prominent barrier identified was financial constraints, which shaped discussions in both focus groups. Notably, the second group explored why certain diabetes technologies remain underutilized despite being available under the UK NHS system [3], where prescribed technology devices are provided at no cost to patients if they are eligible leading to the decision to emphasize awareness and training within the animation. Another critical theme was the need for comprehensive education and a well-established diabetes support network. One participant's longstanding involvement in advocacy networks may have influenced their views, potentially biasing their responses toward more informed or engaged perspectives. This could be considered a limitation.

Consistent with recent studies, our findings support the growing evidence that animation-based educational tools can enhance engagement and satisfaction among young people with chronic conditions [23, 24]. Future research should focus on developing standardized, animation-based educational resources tailored to diabetic children and their families, specifically addressing the barriers identified through co-design. Integrating these materials across the NHS would ensure equitable access to diabetes education, mitigating geographic disparities and improving overall health outcomes. Future phases may involve face-to-face workshops to deepen engagement, and iterative updates to the animation to reflect evolving diabetes technologies. Additionally, a key next step is to evaluate the effectiveness of this resource in increasing technology uptake and improving outcomes, in order to inform future scale-up efforts.

5. Conclusion

This study highlights the crucial role of diabetes technology in managing health while exposing significant access barriers, including misconceptions about cost, lack of awareness, and the financial, logistical, and psychological burdens faced by young people with type 1 diabetes. By employing a systematic co-design approach, we actively involved children and young people (CYP) with type 1 diabetes (T1D) in shaping an animation that authentically reflects their experiences. This participatory process enhanced the resource's relevance and aligned with the generative co-design framework for healthcare innovation, emphasizing deep end-user engagement. The resulting animation serves as a vital tool for raising awareness, improving education, and strengthening support networks. Future research should focus on scaling and standardizing animation-based educational tools within the NHS to ensure equitable access for all young people living with diabetes.

Novelty Statement: Our research presents a novel co-designed animated resource specifically targeting inequities in access to diabetes technologies among children and young people with Type 1 Diabetes from ethnic minority and low socioeconomic backgrounds. While previous studies have explored barriers to diabetes technology use, few have utilized co-design with affected communities to develop culturally tailored, animated educational tools addressing these inequities. This approach uniquely combines qualitative insight and digital health access enhancement through animation.

Author contributions

N.D led this work, wrote the ethics protocol, designed this interview and co-design study with CYPs. S.M.N, conceived the wider UNBIASED study. E.T and N.D. collected the data, which was then analysed by E.T, and N.D and an independent qualitative reviewer. ET and ND drafted the manuscript. All authors reviewed, edited and approved the paper.

Data availability statement

The datasets generated and analysed for this study are not publicly available due to risks to individual privacy. However, the quote tables and the data sets are available, via the corresponding authors, on reasonable request.

Consent

All research participants provided written informed consent including for anonymized information to be published in this article.

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Declaration of competing interest

Co-design of an Animated Resource to understand Inequities in Access to Diabetes Technologies Among Children and Young People with Type 1 Diabetes from Ethnic Minority Groups and/or Low Socioeconomic Areas.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2026.103432.

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