Title: A qualitative investigation to develop an adapted version of the EQ-5D-Y-3L for use in children aged 2-4 years

Running Title: Development of adapted EQ-5D-Y-3L aged 2-4

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Précis

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Abstract

Objectives: Few preference-weighted health-related quality-of-life measures exist for children under 5 years of age. Young children are substantial consumers of health care services. This project aims to assess EQ-5D-Y-3L's appropriateness in children aged 2-4 years and to co-produce with parents a suitable adaptation.

Methods: Purposive sampling at the Murdoch Children's Research Institute and Royal Children's Hospital was used to recruit parents or carers of children aged 2-4 years in Australia. Online focus groups were conducted consisting of 13 parents of well children, and 6 parents of children with moderate to severe health conditions. Parents provided feedback on each dimension of the proxy EQ-5D-Y-3L. Recordings were transcribed and thematic analysis was conducted. Qualitative findings guided the design of adaptations to the instrument. The adaptations were piloted to obtain feedback and refined to improve language translatability and comparability with other EuroQol instruments.

Results: The adapted EQ-5D-Y-3L was considered generally acceptable by parents. Parents provided a wide range of examples of how each domain related to their children, with varied examples provided across ages 2-4 years and health status. Additional or alternative wording was suggested by parents to improve the applicability of the instrument to this age group. One example of this was the change of the domain wording "walking about" to "movement" – ID5: *"In this age group, movement is more important than walking".*

Conclusion: The adapted EQ-5D-Y-3L has improved relevance for 2–4-year-olds and appears easy to complete. Further testing of the adapted instrument is required to evaluate acceptability, reliability, and validity.

Highlights:

- Few generic health-related quality of life (HRQoL) measures are available for the estimation of Quality Adjusted Life Years (QALYs) for children (aged 2-4 years)
- This qualitative study used the views of parents/caregivers of well and un-well children aged 2-4 years to adapt the EQ-5D-Y-3L instrument**.** The adaptations incorporated enhance EQ-5D-Y-3L's relevance and appropriateness for use in the 2–4-year age range
- Additional research is required to assess the reliability, validity, and responsiveness of the adapted EQ-5D-Y-3L. If shown to be psychometrically sound, additional research may be needed to generate a new value set to estimate QALYs for children aged 2-4.

Introduction

Few preference-weighted health-related quality of life (HRQoL) measures are available for the estimation of Quality Adjusted Life Years (QALYs) for very young children.[1–3] The lack of and need for a tool which allows paediatric patient-reported outcomes to be used in economic evaluations have been highlighted by various Health Technology Assessment (HTA) authorities.[4,5] The demand for such a tool is not surprising as young children are substantial consumers of health care services.[6] Additionally, literature reviews have identified the weak evidence upon which paediatric utilities are currently based.[7] Without a suitably validated preference-weighted measure, decision makers' ability to efficiently allocate health care resources across age groups is compromised.

In 2020, three preference-based measures were suitable for young children; the Infant HRQoL Instrument (IQI) (age 0-1), EuroQol Toddler and Infant Populations (EQ-TIPS, formerly TANDI) (age 0-3), and the Neonatal and Infant HRQoL (NIHRQOL) (age 1-3).[8–10] The EQ-TIPS is currently experimental and has only been validated in South Africa. Whereas the IQI and the NIHRQOL are not presently recommended by authorities and are age-specific (infant/toddler) stand-alone instruments that are not part of a family of instruments that can be used to measure HRQoL over an entire age range. There is a clear gap in the coverage of children 2-4 years of age by a multi attribute utility instrument. The EQ-5D-Y and the Child Health Utility Instrument (CHU9D) are two commonly used preference-based instruments to generate generic health state utility scores and QALYs for children above 5 years.[11–13] EQ-5D-Y was adapted from the adult instrument to be used as a proxy, whereas CHU9D was designed for the use in children aged between 7 and 17.[13] Neither were designed for children under 5, although the CHU9D contains a set of untested guidance notes to facilitate its use for under 5 years.

An advantage of using the EQ-5D-Y for young children is that it is part of a family of instruments which are widely recommended for use by HTA bodies globally.[14] This would allow for comparison of outcomes and results from cost-effective analysis obtained in this age range with results from other age groups as the instruments are almost identical with the domains and wording used. Although the EQ-5D-Y was not designed for children under 5, it does contains dimensions that are similar to those included in validated non-preference-based instruments for children aged 2-4 years such as the Paediatric Quality of Life Inventory (PedsQL).[15,16] Although the EQ-5D-Y dimensions may be relevant in children aged 2-4, this has not been widely tested for suitability in this age group. Recent research suggests that the EQ-5D-Y in its current format would not be suitable for younger children, but the production of an adapted version without substantially altering the content or integrity of the instrument may be possible.[17] Below the age of 2 years, substantial changes to the content would likely be needed based on critical differences in the underlying construct of HRQoL.[9] The aims of the present study were to:

1. Explore and assess whether parents/caregivers of children (aged 2-4) consider the domains of the EQ-5D-Y-3L to be appropriate and relevant to assess young children's HRQoL
2. Investigate the type of modifications/adaptations that would be necessary to improve the instruments appropriateness and relevance for the use in young children
3. Assess whether an adapted version of the EQ-5D-Y-3L would be considered appropriate and relevant for children aged 2-4 by parents/carers of children aged 2-4 year

Methods

This study was granted ethical approval by the Royal Children's Hospital (RCH), Melbourne, Australia (Number:68396).

The study reporting was cross-checked with the standards for reporting qualitative research guidelines.[18]

Study design

An exploratory descriptive study design was utilised, collecting data through semi-structured online focus groups with parents of children aged 2-4 years (inclusive). A standard qualitative framework analysis was used to analyze the transcripts, followed by a deductive process allowing data to be analyzed with preconceived themes and research aims.[19] The a priori position of the study was broad alignment to the preconceived themes and aims. This includes the assessment of the appropriateness of the current EQ-5D-Y-3L domains. If a domain/s were deemed problematic, adaptations or alternatives were asked.

Reflexivity

The researchers conducting the group discussions included two health economists and a clinical psychologist, all with formal training in qualitative research. The researchers played an active part in the research. The health economists are experienced in the development, assessment, and use of HRQoL instruments including the EQ-5D-Y. There were no formal or existing relationships between the researchers and the participants.

Recruitment and Sampling

Purposive sampling was used to ensure parents of children with a wide range of health conditions were captured. Recruitment methods included: advertisement posted on the Murdoch Children's Research Institute Facebook page; digital advertisement appearing during participants' outpatient telehealth appointments at the RCH, advertisement flyers at the RCH Early Learning Centre and the playground next to the RCH. Participants were screened for eligibility and were formally

consented. The eligibility criteria included: being a parent/carer of at least one child aged 2-4 years, residing in Australia and English-speaking, and having access to a computer with a microphone, camera, and internet.

The study involved seven focus groups of 19 parents, 16 mothers and 3 fathers, of 22 children aged 2-4 years. Two groups involved participants (N=6) who had children with moderate to severe health conditions while the other groups (N=13) had well children or those with minor health conditions. The health status of the child was indicated by the parents. Focus groups were used as they allow for rich candid discussions where participants thoughts, but also interactions, contribute to the discussion and a building of ideas.[20] Focus groups of two to four participants were utilised based on recommendations of smaller samples for an online format.[21,22] A priori we specified a sample size of around 30 participants. Data collection continued until saturation of information was reached.[23] Saturation was determined when the three researchers all agreed that no new ideas/concepts/thoughts were being introduced.

Information collected from parents and young children, particularly the children with moderate-severe health conditions, was deemed to be highly sensitive by the research team and ethics committee and could lead to potential identification of participants. Ethical constraints meant additional identifiable information, such as socio-economic status, ethnicity, or health-condition of the child, was not recorded from parents or their children. As such, we are unable to describe this level of characteristics in the participants and their children.

Data Collection, handling, and analysis

Focus groups sessions were conducted online via Zoom (approximately 90 minutes long) between November and December 2020. A semi-structured discussion guide (Appendix A) was used to ensure all relevant topics were covered, and also allowed for flexibility throughout the data collection process.[24] Such an approach recognized the "active role" of the researcher and participants and allowed for interview questions to be continually modified. [25]

The discussion guide was developed using several sources: review of the existing HRQoL measures in young children; discussions within the research team; alignment with the research aims; and consideration of the current EQ-5D-Y-3L measure. The discussion guide used open-ended questions to explore three main topics: the suitability of the dimensions in the standard EQ-5D-Y-3L instrument for young children; the interpretation of each dimension in 2–4-year-olds; and whether any elements were missing from the EQ-5D-Y-3L. The guide was piloted with two participants (randomly selected) to gauge their understanding of the questions and to refine wording before discussions with the broader focus groups. Only minor refinement of the wording was made post pilot.

Focus groups were video and audio-recorded via the Zoom recording function. Transcription of the recordings was conducted by two research assistants (both authors) and cross checked for quality control. All identifying information/details about the participants were removed.

Transcripts were coded using NVivo by the same two research assistants (cross checked for quality control).[26] A thematic coding framework (Figure 1) was used to code the transcripts and was developed from several sources: the focus group discussion guide and transcripts, the research team discussion (health economists and researchers), and the existing EQ-5D-Y-3L dimensions. Inductive codes which arose during the coding process were added to the coding framework. Codes were grouped and subsequently refined into higher order analytical themes giving a broader

understanding of the transcripts and the relationship between categories. The data was then used to build an understanding of how parents of children aged 2-4 years define their child's HRQoL, and therefore the subsequent applicability of the EQ-5D-Y-3L instrument. Sub-group analysis by child's age and by child's health status was done to assess any differences in acceptability of the dimensions.

Theoretical approach

This research was undertaken with a phenomenological theoretical approach.[27] In this study, we are understanding the perspectives of parents/carers of children to understand important aspects of health of children, as they play an important role in ensuring and understanding the wellbeing of children in the targeted age group. The theoretical approach informed our understanding of the data and the context of how the data will be used.

Adaptation process

Based on qualitative findings, the researchers proposed changes to the wording of the EQ-5D-Y-3L to make it more suitable for children aged 2-4. These proposed changes were workshopped with a broader research team (four health economists, a health outcomes researcher, a psychologist, and a paediatrician) through online meetings and a series of email communication. The following steps were followed in making adaptations: (1) consideration of qualitative results that suggested the need for new domain or question wording; (2) consideration of qualitative results that suggested the need for modification or addition of examples to tailor to a child aged 2-4 years; (3) comparison of the questionnaire wording with EQ-TIPs to improve consistency; and (4) assessment of the proposed adaptations for ease of translation to prepare the instrument to be translated into other languages. Justifications were recorded along with any difference in opinion.

Proposed adaptations were piloted with five participants of the original focus group who consented to further follow up, with feedback sought on the proposed wording and refinements of the instrument.

Techniques to enhance trustworthiness and credibility

Multiple methods were used to enhance trustworthiness and credibility of data analysis. Audit trail of information, transcription of recordings quality checked by two members, triangulation of interview data by multiple investigators, and member checking through follow-up interviews to check if the adaptations made to the instrument matched and aligned with participant's thoughts.

Results

In total, twelve inductive codes and twenty-five inductive sub-codes were generated from the data (Figure-1). Three analytical themes emerged from the synthesized data, which includes the applicability of EQ-5D-Y-3L dimensions in measuring HRQoL in children aged 2-4 years old, the difference in applicability of dimensions between children aged 2, 3 and 4 years of age, and the difference in applicability of dimensions between well children and children with health conditions. The analytical themes were linked to the inductive codes and sub-codes to inform the usability of the EQ-5D-Y-3L among children aged 2-4 years old.

Applicability of EQ-5D-Y-3L dimensions

Participants reviewed the applicability of each EQ-5D-Y-3L dimensions for their child(ren). The consensus was that the dimensions were relevant to some extent. It was agreed that "looking after self (LAS)" was not applicable in its current wording, but with some modifications to reframe as "helping look after self" could be relevant. Other core issues identified with the current EQ-5D-Y-

3L was the irrelevance of the examples, incorrect choice for some of the wording, and the lack of clarity of some questions. Participants felt that there were better examples of how the dimensions applied to their children and were able to provide details. A simple summary of words and examples used when discussing each dimension is contained in Table-1.

Mobility

Participants expressed that the dimension 'Mobility' was applicable for measuring the HRQoL of their child. However, the only example 'Walking' does not adequately capture healthy mobility among children in this age group (Table-2). Participants felt that the child's progression of mobility was vital, either compared to established developmental milestones, or relative to themself.

Looking After Self

Participants found the 'LAS' dimension particularly challenging to answer for children in this age group and reported that children are not at a developmental stage where they are able to independently look after themselves. However, after discussion, while children are not able to independently look after themselves, parents/carers reported their ability to show interest in looking after themselves and progress towards independently looking after themselves and these were reported as signs of good health (Table-2).

Two signs of being interested in LAS were identified; the ability to listen and comprehend instructions and the ability to ask for help if they are unable to complete a task. For progression, logical growth and scaffolding of abilities over a period were what parents looked for.

Usual Activities

This dimension was seen as applicable in measuring HRQoL of 2-4 years. The main usual activity mentioned for this age group was playing, followed by sleeping and eating (Table-2). Essential elements of usual activities included socializing and engagement, although more so for a 4-year-old. Regarding engagement, participants noted that a healthy child engages in activities independent of their environment.

Parents also wanted more clarification as to whether they were to compare the child to their usual self or to other children their age which can lead to different results. Discrepancies in interpretations were reported, for example some participants interpreted usual activities to include outings such as going to the zoo, while others took it more to mean everyday things like sleeping and eating.

Pain or Discomfort

Pain and discomfort (PD) was seen as applicable in measuring HRQoL. Parents reported that signs of worrying PD include new symptoms, symptoms with long duration, and a high frequency of pain medication needed. Participants mentioned they would not be too worried if the child can be distracted and is able to self-regulate after showing PD. Most parents thought about physical PD. Some parents raised the need to think about mental PD, however the assessment criteria are the same.

Parents noted that they look at a range of factors, rather than a single symptom, to determine if their child is experiencing any PD. It was noted that this was because children are still developing their communication skills, therefore, parents must perform “detective work” to determine if the child is genuinely experiencing any PD. Parents mentioned having to triangulate information from their child(ren) to determine if they are experiencing something different, as it is normal for

children in this age group to have a range of daily emotional expressions that can look like pain (Table-2).

Worried, Sad, or Unhappy

There were varying opinions regarding this dimension. Some participants indicated that children are not sufficiently emotionally developed to experience worry and sadness, that they might instead express frustration or anger and be withdrawn if situations are not in their control. Other participants indicated that it is normal for children to experience worry, sadness, and unhappiness throughout the day (Table-2). Participants stated that an unhealthy sign in this dimension is determined by the persistence and pervasiveness of the emotions, resulting in negative impacts on their daily functions, or if the child is unable to regulate and return from a distressing situation. Participants were also assessing if other needs in the child's life, such as sleeping and eating, were being met to determine cause of emotions.

Difference in applicability by age

Parents highlighted that between the ages of 2 and 4, children are going through distinct stages of development. This was particularly evident in the level of independence and language development as children age. Differences in results could arise between the age of 2 and 4 years as children have rapidly changing capabilities and experiences. We summarized the differences in terms of selfcare, communication, and socialising (Table-3).

Difference in applicability by health status

Parents highlighted that the needs of a child with ongoing health conditions are complex and therefore, measuring the HRQoL compared to a well child raises important differences. One issue

was whether to compare a child to the individual self or to general developmental milestones that represent an 'average' child. We summarized the differences in terms of progression, participate in usual activities, symptoms identification, and independence (Table-3).

Adapted survey

Changes made to the EQ-5D-Y-3L, based upon the qualitative feedback and discussions within the research team, are summarized in Table-4. One change made throughout was the removal of gender pronouns from domain and level-wording, such as "he/she", to reflect gender neutral language in keeping with current best practice, noting that current EQ-5D-Y-3L proxy instruments still use gendered pronouns. The level-wordings were adapted to improve the clarity, suitability, and applicability of the EQ-5D-Y-3L in children aged 2-4 with the addition of tailored examples.

Further explanation on the adaptation was presented in Appendix C, with things considered but omitted presented in Appendix D.

Pilot feedback

Five parents responded with feedback on the adapted instrument. All parents thought the examples provided for each of the five domains were now appropriate and relevant for the age range. With the 'Looking After Themselves' domain, one parent felt that the child's inability to complete these tasks independently was not reflected in the dimension wording. Although, the majority felt that the use of the wording 'helping with…' in the dimension example was sufficient to imply that child was not expected to be independent in the activity. Overall, all parents consistently felt that the adapted EQ-5D-Y-3L was clear, relevant, and easy to complete when thinking about their child.

Discussion

This study co-produced an adapted EQ-5D-Y-3L for 2-4 years through parent focus groups. Parents believed that the broad EQ-5D-Y-3L dimensions were relevant to assess children aged 2-4 years' HRQoL however, the original questionnaire was not age-appropriate or relevant to their children primarily due to the choice of wording, inapplicability of current 'LAS' domain, and a lack of relevant examples. We investigated the gaps in the appropriateness and relevance of the wording using qualitative analysis, and the transcript recordings showed that parents had suggestions for how to make 'LAS' relevant and provided many examples to describe how each dimension related to their child(ren) aged 2-4 years. Detailed factors that need to be considered in each dimension of the EQ-5D-Y-3L were revealed as well as how these important factors vary across the age range and health state of the child. The overall qualitative feedback of the parents, in combination with research team discussions, was used to drive modification and adaptation of the original EQ-5D-Y-3L. Parent pilot feedback suggested that the new adapted EQ-5D-Y-3L was appropriate and relevant for children aged 2-4, and that it was easy to complete. Given the lack of validated proxy HRQoL instruments available for children aged 2-4 years that have been curated with parent or caregiver feedback, we believe this study has provided a useful instrument that could fill this gap.

Both the adapted EQ-5D-Y-3L and PedsQL contain overlapping domains, however, the adapted is preference-based. Compared to the CHU9D, though both preference-based, the development of the CHU9D for under 5-year old's is not clearly described in the literature. Compared to IQI and NIHRQOL, the adapted EQ-5D-Y-3L covers this specific age range and is already widely used. Most importantly, the adapted EQ-5D-Y-3L is part of the wider family of EuroQol instruments allowing for the measure of HRQoL over a greater age range. How children's HRQoL is reflected as they age and switch instruments is important and could be studied in a cohort of children of various ages who are measured with the EQ-TIPs, EQ-5D-Y adapted, EQ-5D-Y original and EQ-

5D with increasing age. The consistency among versions of the EQ-5D measures is beneficial, however the revisions also mean that although the questions are similar, there are subtle differences to the other EQ-5D-Y versions. Further research is needed to explore the potential implications for consistency across instruments.

The strengths of the study include that careful consideration was made for the adaptations to ensure the incorporation of the views of those with lived experience. Consideration was made for ease of translation across languages, and consistency with the existing EuroQol instruments for older children and the experimental EuroQol instrument for younger children, the EQ-TIPS questionnaire. The study outcomes are likely relevant and able to be directly used with the EQ-5D-Y-5L as this study focused only on the acceptance and adaptation of the domains in EQ-5D-Y-3L, rather than the levels. The small, structured focus groups allowed for well organised discussions that focused on the key research topics, while providing a space for all participants to express their thoughts. The inclusion of both mothers and fathers, as well as children with a range of health conditions allowed for diverse thoughts and opinions.

The addition of the word “unusually” in the domain examples was suggested by parents to differentiate changes in the PD or worried, sad, or unhappy domains as children in this age group may exhibit a wide range of emotions throughout the day. This still may not be an appropriate adaptation and highlights the challenges associated with the desire to capture and reflect relatively stable health state measurement in young children whose emotions vary so rapidly. Psychometric testing will be important to establish the known group validity and responsiveness of these domains. The qualitative findings suggest mobility (for this age group) is not just about walking and/or running, but more so about the ability to move about. Moving about may also be a helpful

way of thinking about health states for other populations such as the elderly or those with specific disabilities. This subtle change may prove just as relevant for the suite of EuroQoL instruments in other age groups as it is for 2–4-year-olds. As expected, there were few words/examples provided by participants when describing how each dimension related to their child that spanned multiple domains (e.g., bathing/showering/washing in usual activity and LAS). This highlights the open-ended nature of the study. Psychometric and factor analysis will prove useful to assess the correlation and exclusivity of domains. Although the purpose of the study was not to investigate the framing of the tasks and didn't provide any specific guidance around framing, parents raised that they could compare their child to their usual self or to other children. Additional research is needed to investigate the implications of framing the tasks, which is equally as important for other HRQoL instruments for different age groups.

Several limitations are identified. As this qualitative study was conducted in a single country with all participants from Australia, it is unknown whether the instrument wording would hold when translated for other countries. As mentioned in the methods section detailed participant characteristics such as child's condition, age, gender, race and income were not able to be collected and reported due to ethical constraints and concerns around identification of children with rare conditions. This lack of information may limit interpretation of the sample responses and ability to assess generalisability of findings. Another limitation is that the adapted EQ-5D-Y-3L was pilot tested with participants that had already provided input in the focus group sessions, therefore, we might expect them to approve the final adaptation. Additional research is needed to assess whether the adapted EQ-5D-Y-3L (2-4 years) is equally well-accepted in other countries.

We acknowledge that the research approach was not opened ended when going to focus groups as we intended to build on the existing EQ-5D-Y-3L structure, which aligns with our research

question and objectives. Nevertheless, the results showed that the participants were able to identify areas that needed change, while also highlighting areas that were missing. Though 'LAS' was initially seen as being difficult to relate to their children aged 2-4, parents thought it was important to consider the child's transition towards greater independence by changing the wording to help looking after themselves. Pilot feedback suggested the that adaptations to the LAS domain did improve relevancy in this age group. Communication, playing, socialising, and eating were noted as domains which may not be appropriately covered by the EQ-5D-Y instrument. These additional domains were also raised during the development of the EQ-TIPS instrument for 0–3-year-olds. Although, many participants did feel these may fall within the pre-existing domains. Assessing correlation coefficients alongside a validated instrument that includes these domains and others (e.g., PedsQl) would provide a means to test the extent of potential item overlap or coverage of this instrument for this age group.

In conclusion, this study has led to the development of an adapted proxy version of the EQ-5D-Y-3L questionnaire to measure HRQoL in children aged 2-4 which was shown to be well-accepted by parents. Further testing is required to ensure that this new version is equally acceptable in other cultural contexts as well as studies to assess its reliability, validity, and responsiveness. If the instrument is shown to be psychometrically sound, it should make a useful contribution to assessing health outcomes and the cost-effectiveness of health care technology in these younger populations. Though additional research may be required to develop a new value set for this age group.

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Table 1 Words and examples provided by participants when describing how each EQ-5D-Y-3L dimension related to their child(ren) aged 2-4 years old

EQ-5D-Y-3L Dimension	Words/Examples Participants Used to Describe the Dimension
Mobility	Balance, Carrying, Climb, Coordination, Crawl, Dancing, Fine motor skills, Hang on, Holding, Hopping, Jump, Moving, Picking up, Playing, Pointing, Run, Safety, Skipping, Throwing, Using hands/arms, Walking
Looking After Self	Ask for help, Ask/getting drink, Communicating hunger, Dressing/undressing, Emotional regulation, Express what they want, Feeding self, Getting lunch out of bag, Listen/follow instructions, Look when crossing road, Packing away, Picking clothes, Playing safely, Put on shoes, Self-regulating sleep, Sensing danger, Showering/washing, Taking medication, Toileting, Understanding danger, Washing hands, Washing up
Usual Activity	Arts and craft, Bathing, Child-care, Communicating/talking, Crying, Eating, Helping around house, Learning, Listening, Outdoor play, Playing, Read books/stories, Run, Sleeping, Socialising/playing with friends, Swimming, Time with family, Using imagination, Zoo
Pain or Discomfort	Change in behaviour, Clingy, Communicating pain, Cranky, Crying, Distress, Frequency of pain medication, Immobility, Irritable, Lack of enjoyment, Lethargy/fatigue, Longer than usual, Mental discomfort, Moaning and groaning, More than usual sleep, Not eating, Not going to toilet, Not sleeping, Not wanting to play, Physical symptoms (bruises, rash), Pointing to sore part of body, Reduced skills, Refusals (nappy, day care, clean nose), Separating problems,

	Showing action or itch/scratch, Sore, Teething, Temper tantrums, Unable to be distracted, Unable to do activity, Unable to sooth, Uncomfortable, Upset
Worried, Sad, or Unhappy	Acting out, Angry, Attachment, Avoiding people, Change from normality, Change in behaviour, Change in emotion, Change in expression, Confused, Coping, Crying a lot, Disagreement, Distressed, Emotional, Frustrated, Impacting sleep or appetite, Impacts daily functioning, Inability to regulate, Lack of interest, Needing more attention/clingy, Nervous, Persistent, Physical outburst, Sadness, Security, Seeking reassurance, Suck their thumb, Tantrums, Un-cooperation, Unable to complete task, Unhappy, Withdrawn

Table 2 Important factors raised by participants when describing how each EQ-5D-Y-3L dimension related to their child(ren) aged 2-4 years old

Important factors raised	Quotes*
MOBILITY	
The use of word 'walking' limits ability to think about healthy mobility	*ID5: "In this age group, movement is more important than walking […]"* *ID1: "If he can walk, but can't move (his) arms, there is something wrong with (his) mobility".*
Importance of progression of mobility	*ID5: "I think walking is definitely one skill, but then running, jumping […], the progression of gross motor skills is another component you watch develop"*
LOOKING AFTER SELF	
Interest in looking after themselves and progress towards	*ID8: "[…]interest in it [looking after self], ability to assist or participate in it, then ability to independently do it. It is a progressive thing."*
Comprehending instructions and asking for help	*ID3: "… I thought about comprehension that the child needs to understand … what needs to be done. If he doesn't understand my communication or anyone's communication, I could be worried. And the next part is, they need to be able to communicate their needs to other people…"*
Importance of growth/improvement in ability to look after self	*ID6: "Being able to follow instructions and perform adult activities, make them feel independent and that they are looking after*

	themselves with guidance. Starting to participate with things that we do as adults."
USUAL ACTIVITIES	
Clarification of the dimension wording ("Usual activity" interpretation varied)	*ID16: "The term usual activities is a hard concept to understand. Activities of daily living might be more appropriate."*
Play identified as main usual activity for the age group	*ID3: "Play is the most important. It is what they do mainly. (Their) life revolves around playing"*
PAIN AND DISCOMFORT	
Developing child communication skills means parents look for multiple unusual factors to determine pain.	*ID6: "I use a checklist to determine if my child is experiencing pain and discomfort. Are they crying more than usual? Are they not sleeping? Has this been going on longer than usual? Are they not their usual self? Not wanting to go out and play? If they answer yes to a few of these questions, that is saying there is something not right"*
Duration and persistence of pain	*ID18: "Having some pain and discomfort can be interpreted very broadly […] Mild pain but long duration can be equal to severe pain and short. It can be tricky to answer if a child has any of these issues to know if they are having some or a lot of pain or discomfort"*
WORRIED, SAD OR UNHAPPY	
Transition through multiple emotions daily	*ID17: "I would say my child isn't worried, sad or unhappy, but she (does experience these emotions) every day at some point but mostly*

	she is happy, good, and fine. There is a wide range of intense emotion in a 3yo"
Persistence and pervasiveness of emotion indication of problem	*ID6: "It would be a sign of worry if there is persistent sadness. Distressed might be a better word as it goes beyond the normal range of emotion"*

*****To enhance readability of the quotes, phrases such as 'um' and 'ers' were removed, and non-essential information within quotes has been replaced with ellipses […].

Table 3 Key differences between the age and the health state of a child noted by participants

	Researcher summary	Quotes*
Differences between 2 to 4-year-olds		
Selfcare: Older children have a greater capacity to look-after self	There is a lot of variation between a 2-year-old and 4-year-old when it comes to looking after themselves due to their ability to be self-sufficient. As a result, when answering the questionnaire, a parent of a 2-year-old might answer that their child has more problems looking after themselves compared to a parent of a 4-year-old, as a 2-year-old is more dependent on their parents to look after themselves to carry out daily activities. Reframing the question to ask children's interest to look after themselves rather than their skills would more accurately capture HRQoL in this domain.	*ID7: "as in dressing self for example. A 2-year-old might be able to undress themselves slowly or just learning to whereas my 4-year-old is dressing herself completely, and multiple times a day. That is a big one. Also, personal hygiene, washing in the shower, my 4-year-old can wash herself. We are still supervising; she likes her back scrubbed which we do for her but the rest she can do. The 2-year-old can't but will have a go at it"*
Communication: Older children have a greater ability to communicate emotions	The variation in language development between 2- to 4-year-olds impacts their ability to communicate. An older child has better ability to express and understand the reason why they are	*ID8: "I think that a 4-year-old remembers and holds onto things […] They are aware and more reflective of emotions. 2-year-old is up and down in emotions, and how*

	feeling a certain way, therefore, they are better able to express when they are feeling any pain or discomfort, and if they are worried, sad, or unhappy. This can therefore influence a parent's interpretation of their child's perspective of experiencing problems within these dimensions.	*she deals with things and remembers things"*
Socialising: Socialising is likely more important for older children as they are more likely to attend an early learning program or day-care	The ability for a child to express themselves is an important component for socialising. The variation in language development and communication between 2-to-4-year-old will lead to a variation in their ability to socialise. Additionally, socialising is more important for a 4-year-old compared to a 2-year-old as they are more likely to attend day care or an early learning program. Therefore, an issue with socialising might be more prominent in a 4-year-old compared to a 2-year-old.	*ID4: "to me socialising is spending time with her peers, especially for 4-year-old. Not 2-year-old yet. But 4-year-old is such a big deal"*
Differences between well children and children with conditions		

Progression: Children with health conditions compared to self-improvement rather than typical developmental milestones	Participants of children with health conditions (some of which were very complex and ongoing health concerns) noted that they do not measure their child's progression based on developmental milestones, but instead, based on the individual child's progression.	*ID12: "Weight wise they were never on the chart, but they were tracking in the right direction and that was the thing to focus on and was heading in right direction. They might not be where peers are at some age. But compare to themselves is different."*
Participation in usual activities: Children with health conditions less able to partake in activities	Further, these participants mentioned that the application of dimensions was different for their children. One participant talked about the challenges of their child socializing outside their usual environment. Parents provided examples of how they thought differently with extra considerations about the dimensions because of their children's condition.	*ID9: "It can be challenging to socialise in a safe way with allergies […] When the child isn't in their usual environment, the child also has a level of anxiety and will not be able to fully participate in the activity. They might have had that experience (anaphylaxis), and now they are concern that might happen again"*
Symptom identification: Changes in emotions and	Participants mentioned that it is easier to notice symptoms of pain or discomfort and variation in emotions in a well child compared to a child with conditions.	*ID2: "As a parent of child who is not usually sick, maybe it's easier for me to tell, never had temp, so if he did, I might be a bit more worried. A parent of child*

feelings more apparent in well children	Children with conditions more frequently face complications. Participants mentioned they were not sure if the change in physical and mental wellbeing is a response to a new treatment and clinician visits or if it is something that is inherently going wrong.	*who is sick all the time, it might be harder for them"*
Independence: Children with health conditions may have greater independence compared to well children at the same age	One participant mentioned that their child has a level of independence that well children their age might not have, and this is due to their frequent contact with the health system.	*ID9: ""I've also kind of found that with my child he does want to help look after himself, not just with medication, but with processes with hospitals and GP where he might assist doctors with thermometers etc. He wants to be a part of it because it's a big part of his life. Whether that's just relating to what another parents' comments, helping to push that, I want to learn how to do this. I think that might be a thing, particularly with kids who have chronic conditions. Keen to have independence and learn to have control over"*

*To enhance readability of the quotes, phrases such as 'um' and 'ers' were removed, and non-essential information within quotes has been replaced with ellipses […].

Table 4. Summary of changes proposed for the EQ-5D-Y-3L to adapt to be suitable for proxy reporting of children aged 2-4 years

Current wording **	Adapted wording	Adaptation Rationale
MOBILITY No problems walking about Some problems walking about A lot of problems walking about	**MOBILITY** (For example: walking, running, jumping at an age-appropriate level) No problems with movement Some problems with movement A lot of problems with movement	**Level wording:** "walking about" changed to "with movement" to improve appropriateness and to reflect the wider movements in children aged 2-4 years (also more culturally appropriate). **Domain example:*** New example added: "For example: walking, running, jumping; at an age-appropriate level". "at an age appropriate level" added to allow for interpretation based on child's age and developmental milestones, and to maintain consistency with the EQ-TIPS instrument
LOOKING AFTER HIM/HERSELF No problems washing or dressing themself Some problems washing or dressing themself	**LOOKING AFTER THEMSELVES** (For example: helping with washing, dressing, toileting at an age-appropriate level) No problems with helping look after themselves	**Level wording:** "washing or dressing myself" changed to "with helping look after themselves" to reflect a children participating rather than being independent. "I have" removed to reflect proxy language **Domain example***

A lot of problems washing or dressing themself	Some problems with helping look after themselves A lot of problems with helping look after themselves	New example added: "For example: helping with washing, dressing, toileting; at an age-appropriate level". "at an age appropriate level" added to allow for interpretation based on child's age and developmental milestones, and to maintain consistency with the EQ-TIPS instrument.
DOING USUAL ACTIVITIES (for example, work, study, housework, family or leisure activities) No problems doing their usual activities Some problems doing their usual activities A lot of problems doing their usual activities	**DOING USUAL ACTIVITIES** (For example: everyday activities such as playing, socializing, sleeping, eating at an age-appropriate level) No problems doing usual activities Some problems doing usual activities A lot of problems doing usual activities	**Domain example*** Existing example deleted as not appropriate for children aged 2-4 years. New example added: "For example: everyday activities such as playing, socializing, sleeping, eating; at an age-appropriate level". "everyday" added to reduce confusion with special events. "at an age appropriate level" added to allow for interpretation based on child's age and developmental milestones, and to maintain consistency with the EQ-TIPS instrument.
HAVING PAIN OR DISCOMFORT No pain or discomfort	**HAVING PAIN OR DISCOMFORT**	**Domain Example***

Some pain or discomfort A lot of pain or discomfort	(For example: unusually irritable, crying for a long time, not able to be settled) No pain or discomfort Some pain or discomfort A lot of pain or discomfort	New example added: "For example: unusually irritable, crying for a long time, not able to be settled". "unusually" and "for a long time" added to reflect the changes of a child's usual behavior.
FEELING WORRIED, SAD OR UNHAPPY Not worried, sad or unhappy A bit worried, sad or unhappy Very worried, sad or unhappy	**FEELING WORRIED, SAD OR UNHAPPY** **(**For example: unusually persistent angry, scared, needy, withdrawn) Not worried, sad or unhappy A bit worried, sad or unhappy Very worried, sad or unhappy	**Domain Example*** New example added: "For example: unusually persistently angry, scared, needy, withdrawn". "unusually" added to reflect the changes of a child's usual behavior.

*Proposed changes to domain examples based on the examples participants commonly used to describe children between the ages of 2 and 4 years old (Table 2)

** Note that gendered pronouns have been dropped from the original proxy manuscript wording across the manuscript, in keeping with current best practice.