# Parental preferences for brace weaning in developmental dysplasia of the hip: a discrete choice experiment

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## Aims

To elicit and quantify parental preferences for brace weaning strategies in the treatment of developmental dysplasia of the hip (DDH) and explore how parents trade between treatment burden and the risk of further intervention.

## Methods

A discrete choice experiment (DCE) was developed to assess preferences for timing and duration of weaning, alongside trade-offs related to the risk of further treatment. Parents of infants treated for DDH were recruited via STEPS Worldwide, a patient charity. Parents completed 16 hypothetical scenarios comparing different weaning regimens with immediate cessation. Data were analyzed using conditional logit models. A secondary analysis excluded participants with irrational or disengaged responses. Subgroup analysis explored whether preferences varied by experience.

## Results

A total of 195 respondents completed the survey. In the primary analysis, night-time brace wear was preferred over immediate cessation, even when risk remained equal. In the secondary analysis, which excluded internally inconsistent responses, all weaning strategies were significantly less preferred than immediate cessation under equal risk conditions. Parents were willing to accept longer durations of treatment in exchange for reduced risk of subsequent intervention. The minimum acceptable risk reduction required for parents to accept four additional weeks of brace wear, compared with immediate cessation, was 5.8% (night-time bracing), 7.5% (night-time and naps bracing), 8.4% (gradual brace reduction), and 10.0% (daytime bracing). Preferences varied by experience, especially age at diagnosis and prior weaning.

## Conclusion

Night-time-only weaning was the most acceptable weaning strategy. Parents were willing to trade longer brace treatment for a lower risk of further intervention. We were able to quantify the size of the benefit required by families, which may inform research investigating the effectiveness of weaning strategies.

## Take home message

- Parents prioritize reducing the risk of further treatment and are willing to accept additional brace wear (especially night-time-only use) if the perceived benefit is sufficient.
- These findings inform the design of future research.

## Introduction

Developmental dysplasia of the hip (DDH) is the most common orthopaedic condition in infants, typically managed with bracing

during early life.[1-3] Early intervention with devices such as the Pavlik harness is generally effective, particularly when initiated within the first few months of life.[4] However, there is ongoing debate regarding the necessity and design of a 'weaning' period when discontinuing brace use.

In the UK, 65% of clinicians immediately remove the brace, while the remaining 35% wean.[5] While weaning is practiced by a minority of clinicians in the UK, it is the predominant practice internationally. Surveys indicate that two-thirds of members of the Paediatric Orthopaedic Society of North America (POSNA) and half of those from the European Paediatric Orthopaedic Society (EPOS) use some form of weaning regimen when treating infants.[6] Consensus exercises have produced mixed results about the necessity for weaning. The International Hip Dysplasia Institute (IHDI) supports weaning with night-time use only,[7] whereas the British Society for Children's Orthopaedic Surgery (BSCOS) has not reached a consensus.[8] There is limited evidence to guide practice, with no randomized controlled trials and only two relatively small observational studies investigating the impact of weaning.[9-11]

A discrete choice experiment (DCE) is a stated preference method used to understand how individuals make decisions when faced with competing options. In DDH, a DCE can explore how parents weigh different features of weaning regimens against the risk of requiring further treatment. Including a default option of immediate cessation with a constant risk level allows comparison between weaning strategies and no weaning. By quantifying these trade-offs, a DCE provides insights into parental preferences that can support shared decision-making and inform the design of future clinical trials evaluating weaning strategies.

This study aims to elicit parental preferences regarding weaning from brace treatment in DDH using a DCE. It quantifies the importance of weaning attributes, examines trade-offs with the risk of further intervention, identifies the risk reduction needed to justify weaning, and explores variation by demographic and clinical factors.

## Methods

The study was conducted in accordance with established methodological guidelines for the implementation of DCEs.[12,13] Ethical approval was awarded on 7 January 2025 by the University of Liverpool, UK (Reference: 15575). Informed consent was obtained from all participants prior to their inclusion in the study.

### Attribute and level selection

Attributes and levels were identified using a mixed-methods approach, incorporating prior work with families and clinicians and supported by a literature review to ensure comprehensive coverage of current practice. Weaning regimens were characterized by two key attributes: the timing of brace wear during the day (night-time only, night-time and naps, gradual reduction in total hours per day or daytime only); and the duration of brace wear, ranging from two to 12 weeks. 'Hours per day', although relevant to reduction-based regimens, was not included as a separate attribute due to its overlap with timing of wear. Its inclusion risked generating illogical combinations and would have compromised the orthogonality of the design. The risk of further intervention (e.g. bracing or surgery) was chosen as the 'trade-off', as it was more relevant to parents than surrogate radiological measures. The attributes and levels included in the DCE are presented in Table I.

### Survey development and design

A D-efficient fractional factorial design was generated using Ngene software, producing 16 optimized choice tasks.[14] Scenarios were defined by two explanatory attributes (timing and duration of brace wear) and one trade-off attribute (the risk of further intervention including further bracing or surgery). The design was developed in consultation with the STEPS Worldwide[15] charity and a parent representative.

Each scenario presented three options: two weaning regimens and a default alternative, immediate cessation of bracing. The weaning regimens varied in timing, duration, and associated risk of further intervention. Immediate cessation was assigned a fixed 20% risk, based on the highest plausible estimate reported in the literature, and was consistently associated with the highest or a comparable risk relative to the weaning strategies.[16,17]

Participants completed all 16 hypothetical scenarios, selecting the option they would prefer for their child:[1] a weaning regimen;[2] an alternative weaning regimen; or immediate cessation of bracing.[3] An example choice task is shown in Figure 1.

In addition to completing the choice tasks, parents were asked to provide demographic and clinical information, including their role (e.g. mother or father), the age of their infant at diagnosis, whether treatment was successful, the duration of full-time brace wear, and whether their child underwent a weaning regime.

### Pre-testing

Three parents were recruited via the STEPS charity to undertake a 'think-aloud' pretest.[18,19] Parents received instructions for completing a think-aloud exercise, followed by the standard survey instructions. They completed the survey while verbalizing their thoughts. Feedback indicated that the survey was clear and manageable. As no major difficulties were identified for families, the pretest responses were retained in the final dataset.

### Sample and recruitment

Guidance on sample size calculation for healthcare-related DCEs is limited, though evidence suggests smaller samples can still yield valuable insights.[20,21] We used Orme's sample size calculation: $N \geq (500 \times C)/(t \times a)$, where $C$ is the maximum number of attribute levels, $t$ is the number of choice tasks per respondent, and $a$ is the number of alternatives per task (excluding the 'none' option).[22] With $C = 6$, $t = 16$, and $a = 2$, this yielded a recommended sample size of 94.

Participants were recruited in collaboration with the STEPS charity through social media and their email list. The DCE was open to all parents of children treated for DDH, irrespective of the treatment received or outcome.

### Participant characteristics

Recruitment was conducted between 10 February 2025 and 17 March 2025. A total of 195 respondents completed the full

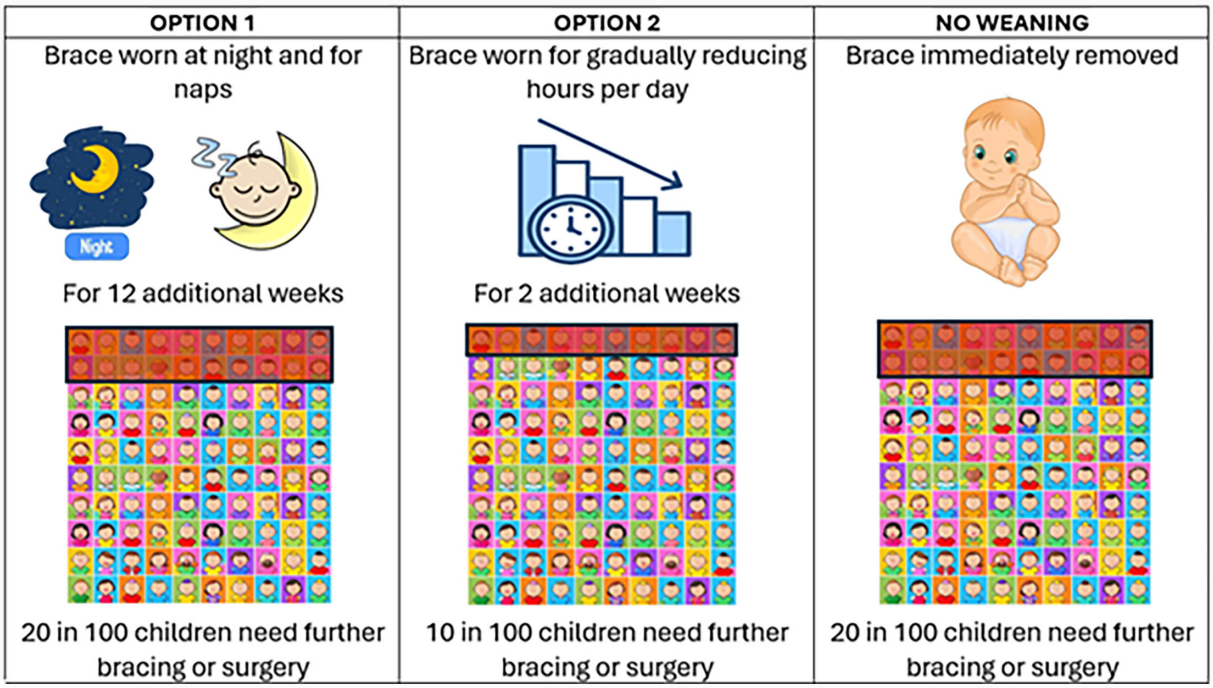


**Fig. 1**
An example choice task.

**Table I.** The attributes and levels included in the discrete choice experiment.

| Attributes | Levels |
|---|---|
| **Explanatory**: timing of brace wear | Night-time only |
| | Night-time and naps |
| | Gradual reduction in total number of hours worn per day |
| | Daytime only |
| **Explanatory**: length of weaning regime, wks | 2 |
| | 4 |
| | 6 |
| | 8 |
| | 10 |
| | 12 |
| **Trade-off**: risk of requiring further intervention, % | 5 |
| | 10 |
| | 15 |
| | 20 |

survey. Demographic and clinical characteristics are summarized in Table II. The primary analysis included all completed responses. To quantify parental preferences, a conditional logit model was used.

### Statistical analysis

Responses were analyzed using a conditional logit model in Stata v. 18.0 (StataCorp, USA),[23] which estimates the probability of choosing an alternative based on the utility derived from its attributes. Grounded in random utility theory, the model assumes that participants select the option offering the highest utility in each choice task.[24]

This model was used to estimate preferences for individual weaning attributes and to quantify how participants weighed these preferences against the associated risk of requiring further intervention (e.g. bracing or surgery). The primary analysis included all responses. A secondary analysis was conducted in which participants who provided at least one 'irrational' response were excluded. An 'irrational' response was defined as selecting a weaning strategy over immediate cessation when both options carried the same level of risk. Participants who consistently selected the same weaning strategy across all choice tasks, a behaviour known as straightlining, were also excluded, as this pattern suggests a lack of engagement with the survey. In contrast, participants who consistently chose the opt-out alternative were retained, as this was considered a rational and intentional expression of preference.[25] The secondary analysis was used to estimate marginal rates of substitution (MRS) between attributes to evaluate how participants traded increased treatment burden, defined as additional weeks in a brace and the timing of wear, against reduced risk of further intervention. MRS values were calculated as the ratio of the relevant attribute coefficients. To contextualize these trade-offs, the total disutility of each weaning strategy over a four-week period was calculated by summing the attribute-specific coefficient with the disutility from four weeks of brace wear. Total disutilities were divided by the risk coefficient to estimate the percentage risk reduction required for each strategy to be equally acceptable to immediate cessation. Subgroup analysis was undertaken to assess whether late diagnosis, unsuccessful brace treatment, or weaning affected results. Statistical significance was set at $p < 0.05$.

**Table II.** Participant and infant characteristics.

| Variable | N (%) |
|---|---|
| **Participant role** | |
| Mother | 191 (97.9) |
| Father | 4 (2.1) |
| **Participant country** | |
| UK | 95 (48.7) |
| USA | 58 (29.7) |
| Australia | 17 (8.7) |
| Canada | 11 (5.6) |
| Ireland | 6 (3.1) |
| New Zealand | 3 (1.5) |
| Chile, Croatia, Netherlands, Philippines, Portugal* | 5 (2.5) |
| **Care of infant, related to the participant completing the form** | |
| **Infant age at diagnosis, mnths** | |
| ≤ 3 | 162 (83.1) |
| 4 to 6 | 20 (10.3) |
| 7 to 9 | 6 (3.1) |
| 10 to 12 | 7 (3.6) |
| **Duration of treatment, wks** | |
| ≤ 6 | 27 (13.8) |
| 7 to 12 | 72 (36.9) |
| > 12 | 61 (31.3) |
| Ongoing/interrupted | 35 (17.9) |
| **Weaning practices** | |
| Ongoing full-time brace use | 18 (9.2) |
| Completed a weaning regime | 70 (35.9) |
| Immediate brace cessation | 96 (49.2) |
| Early termination for alternative treatment | 11 (5.6) |
| **Treatment outcome** | |
| Completed brace treatment without further intervention | 126 (64.6) |
| Required further treatment post-bracing | 46 (23.6) |
| Ongoing brace treatment | 23 (11.8) |

*One respondent each from Chile, Croatia, Netherlands, Philippines, and Portugal.

## Results

Table III presents the estimated coefficients, standard errors, and p-values. In this analysis, coefficients represent the relative strength and direction of preference for each attribute level compared with immediate cessation, which was fixed at zero. Positive coefficients indicate a higher likelihood of selection compared with immediate cessation, whereas negative coefficients indicate a lower likelihood.

Participants' preferences for weaning strategies were assessed relative to immediate cessation, holding the risk of further intervention constant. The most preferred strategy was night-time-only brace wear, followed by night-time and naps, gradual reduction, and daytime-only wear, which was the least preferred. Night-time-only brace wear was associated with a statistically significant preference (coefficient 0.432, standard error 0.090; $p < 0.001$). The preference for night-time and naps was positive but not statistically significant (coefficient 0.152; $p = 0.119$). Gradual reduction and daytime-only brace wear were both significantly less preferred than immediate cessation ($p < 0.001$ and $p = 0.008$, respectively).

Participants also showed a strong aversion to increasing the risk of further intervention (coefficient -0.189 per 1% increase; $p < 0.001$) and to longer weaning durations (coefficient -0.099 per additional week; $p < 0.001$), indicating that both higher risk and longer treatment duration reduced the likelihood of a weaning strategy being chosen.

A secondary analysis was conducted excluding participants who provided at least one irrational response or who displayed straightlining behaviour. In this analysis ($n = 90$), all weaning strategies were significantly less preferred than immediate cessation. Table IV presents the estimated coefficients, standard errors, and p-values from the conditional logit model. The most preferred weaning strategy relative to immediate cessation was night-time brace wear only ($p < 0.001$), followed by night-time and naps ($p < 0.001$), gradual reduction ($p < 0.001$), and daytime brace wear, which was the least preferred ($p < 0.001$).

As in the primary analysis, participants demonstrated a strong aversion to higher risk ($p < 0.001$) and longer treatment duration ($p < 0.001$), both of which reduced the likelihood of selecting a weaning strategy.

Parents demonstrated a willingness to accept increased treatment burden in exchange for reduced risk of further intervention. On average, respondents were willing to accept 1.6 additional weeks of bracing to achieve a 1% reduction in risk.

The values presented in Table V show the total disutility associated with each weaning strategy applied over a four-week period, calculated by combining the attribute-specific coefficient with the disutility of four weeks of brace wear. The corresponding risk reduction values indicate the percentage decrease in risk of further intervention required to make each strategy equally acceptable to immediate cessation. Based on the overall utility of night-time brace wear, a reduction in risk of approximately 5.8% would be required to make four weeks of night-time bracing equally acceptable to immediate cessation.

Subgroup analyses explored whether preferences for weaning strategies varied according to personal experience. Among participants whose infants were diagnosed after aged six months, lower coefficients were seen for all weaning strategies compared with the overall sample, indicating reduced acceptability of continued bracing in this group. Respondents whose infants had required further intervention following initial brace treatment showed similar preference patterns to the full cohort, with coefficients of comparable direction and magnitude. Differences were observed according to reported weaning experience. Participants who had weaned their infants demonstrated greater acceptance of night-time brace wear, compared with those who had stopped bracing immediately. In the weaning group, night-time brace

**Table III.** Primary analysis estimated coefficients, standard errors, and p-values.

| Attribute | Coefficient | Standard error | p-value* |
|---|---|---|---|
| Night-time brace wearing | 0.432 | 0.090 | < 0.001 |
| Night-time and naps brace wearing | 0.152 | 0.098 | 0.119 |
| Gradual reduction in brace wearing | -0.278 | 0.104 | < 0.001 |
| Daytime brace wearing | -0.611 | 0.107 | 0.008 |
| Risk of requiring further intervention | -0.189 | 0.006 | < 0.001 |
| Length of weaning regime | -0.099 | 0.007 | < 0.001 |

*Conditional logit model in Stata v. 18.0.

**Table IV.** Secondary analysis estimated coefficients, standard errors, and p-values.

| Attribute | Coefficient | Standard error | p-value* |
|---|---|---|---|
| Night-time brace wearing | -0.844 | 0.140 | < 0.001 |
| Night-time and naps brace wearing | -1.308 | 0.162 | < 0.001 |
| Gradual reduction in brace wearing | -1.531 | 0.167 | < 0.001 |
| Daytime brace wearing | -1.957 | 0.183 | < 0.001 |
| Risk | -0.262 | 0.011 | < 0.001 |
| Weeks | -0.166 | 0.013 | < 0.001 |

*Conditional logit model in Stata v. 18.0.

**Table V.** Estimated total disutility and required risk reduction for each weaning attribute (secondary analysis).

| Weaning attributes | Total disutility | Risk reduction needed, % |
|---|---|---|
| Night-time brace wearing | –1.508 | 5.8 |
| Night-time and naps brace wearing | –1.972 | 7.5 |
| Gradual reduction in brace wearing | –2.195 | 8.4 |
| Daytime brace wearing | –2.621 | 10.0 |

wear was not statistically significantly different from the opt-out alternative (p = 0.468), while in the non-weaning group, all weaning strategies remained significantly less preferred than cessation. These findings suggest that while the direction of preferences was largely consistent across subgroups, the strength of preferences was moderated by clinical context, particularly age at diagnosis and prior experience of weaning.

## Discussion

In the primary analysis, night-time brace wear emerged as the most preferred weaning strategy, followed by night-time and naps, gradual reduction, and finally daytime wear. When the risk of further intervention was held constant, the overall cohort showed a preference for night-time and night-time-and-naps weaning strategies over immediate cessation, despite no associated reduction in risk. At face value, this response may appear illogical, as it involves continued brace use without additional clinical benefit. However, literature on stated preference methods consistently highlights that such responses are often not truly illogical; rather, they reflect underlying values or interpretations that are not immediately apparent from the choice data alone.[26–28] One possible explanation is that parents may perceive a gradual transition out of bracing as less abrupt and more manageable than immediate cessation. This may provide a sense of control or emotional reassurance during what can be a stressful period. However, this interpretation is somewhat at odds with existing qualitative literature, which consistently emphasizes the burden of brace wear on families.[29,30] Further qualitative research would be valuable to understand whether weaning is perceived by some parents as a more acceptable or comforting approach, despite the additional treatment burden.

A second explanation may relate to how participants interpreted the choice tasks. Although the survey was pretested and found to be understandable, it is well-established that risk is a complex and often misunderstood concept in decision-making.[31–33] In this study, immediate cessation was associated with a fixed 20% risk of further intervention as the highest plausible estimate based on existing literature. Participants were therefore frequently presented with choices between options that all carried relatively high risk. In this context, some parents may have reasoned that limited continued bracing (such as night-time use) might offer even a small chance of benefit and therefore was worth attempting despite the fact that no actual reduction in risk was presented in those scenarios. This is consistent with the strong risk aversion observed throughout the DCE, where lower-risk options were consistently preferred, even when they involved greater treatment burden.

To address the potential influence of disengaged or irrational responses, a secondary analysis was conducted excluding participants who made at least one illogical choice or showed patterns consistent with straightlining. The findings remained consistent with the primary analysis in terms of the direction of preferences, though effect sizes were larger and all weaning strategies were significantly less preferred than immediate cessation. This refined model likely reflects improved data quality and highlights the importance of careful respondent screening in stated preference research. It could be perceived that the secondary analysis simply reflects the removal of participants who expressed a preference for weaning over immediate cessation. However, exclusions were based on predefined criteria of internal inconsistency, specifically selecting a more burdensome option over an equally risky but less burdensome alternative, rather than on stated preferences alone. This practice is well-supported in the stated preference literature as a means of enhancing the internal validity of model estimates.[26,34] Moreover, the consistency in the direction of preferences across both analyses suggests that the refined model served to clarify,

rather than distort, the underlying decision-making patterns observed in the full sample.

The secondary analysis also enabled the estimation of trade-offs between treatment burden and risk, offering insight into how parents value additional bracing relative to reductions in the likelihood of further intervention. These trade-offs provide a useful framework for informing future clinical trial design, including the selection of outcome thresholds that reflect differences considered meaningful by parents. In particular, the quantified value parents place on risk reduction can be used to inform sample size calculations and the selection of non-inferiority or superiority margins that are both statistically and clinically relevant. Incorporating parent-derived thresholds in trial planning ensures that outcomes are not only statistically robust but also relevant to those directly affected by treatment decisions.

Subgroup analyses suggested that preferences were moderated by clinical experience. Parents of infants diagnosed after six months of age demonstrated consistently lower utility for all weaning strategies. Those whose infants required further treatment showed similar preferences to the overall sample, whereas parents who had experienced a weaning regime showed more favourable views of night-time weaning, suggesting their preferences may have been shaped by familiarity or perceived benefit.

Although clinician perspectives are undoubtedly important in the wider debate on brace weaning, their inclusion in this discrete choice experiment was intentionally avoided. Parents act as proxy decision-makers for infants and ultimately determine participation and adherence; their willingness to trade treatment burden against reductions in risk was therefore the primary focus. Incorporating clinicians would have risked conflating distinct perspectives, as attributes would need to be framed in ways meaningful to both groups, potentially reducing validity for each. By restricting the sample to caregivers, we were able to capture parental risk tolerance in a clear and undiluted manner. Clinician views on brace weaning have been explored separately.[35]

While the overall sample size met recommended thresholds for DCE analysis, subgroup analyses were based on smaller numbers and should be interpreted with caution. The study sample was predominantly composed of mothers and largely represented families from the UK and other high-income western countries, and as such, the findings reflect the views and preferences of this demographic. Participants had varied experiences of DDH treatment, including differing treatment durations, outcomes, and approaches to brace weaning. The sample was also skewed toward highly engaged respondents, many of whom were recruited via a patient charity. This may limit the generalizability of findings to broader populations.

Additionally, as with all stated preference methods, hypothetical bias remains a concern, as responses may not fully reflect real-world decision-making.

Nonetheless, this study makes a significant contribution to a sparsely researched area. Brace weaning remains highly variable in clinical practice, with no consensus reached on its necessity or optimal design. By incorporating the voice of parents, those directly affected by treatment decisions, this study provides a foundation for patient-centred care. Parents prioritized reducing the risk of further intervention and were willing to accept additional brace wear, particularly night-time-only use, if the perceived benefit was sufficient. These findings offer valuable insights to inform the design of future clinical trials and ensure they reflect family priorities.

## Social media

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D. C. Perry: Conceptualization, Supervision, Writing – review & editing.
C. Plumpton: Project administration, Writing – review & editing.

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## Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

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