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Bayesian analysis of parental intentions to promote physical activity in young people with cerebral palsy

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Received: 11th February 2024; Accepted: 1st March 2025; Published: 24th November 2025

Abstract: This study investigates the determinants of parents' intentions to support physical activity in their children with cerebral palsy (CP), guided by the Theory of Planned Behavior (TPB). It is hypothesized that parental intention to support PA in young people with CP will be influenced by attitude, subjective norms, and perceived behavioural control. Sixteen parents of young people with CP participating in the Exercises for CP (EXECP) intervention, were surveyed using a questionnaire developed based on the TPB constructs: Attitude, subjective norms, perceived behavioural control, and intention. Data was collected prior to the 3-month EXECP intervention, after the participants had already familiarized themselves with study procedures. A Bayesian statistical approach was central to the study´s methodology, employing Bayesian regression analysis, Bayesian correlation and model comparison tests, to evaluate the determinants of parental intentions to support physical activity in their young people with CP. The results showed that perceived behavioural control is the predominant factor influencing parental intentions, overshadowing attitude, and subjective norms. This finding underscores the crucial role of parents' perceived capabilities in facilitating physical activity in young people with CP. These insights highlight the need for interventions that strengthen parental efficacy and provide accessible resources, focusing on tailored, parent-centric strategies. Emphasizing perceived behavioural control as a crucial factor, the findings suggest pathways for interventions that empower parents with the knowledge and resources to facilitate physical activity in their children with CP.

Keywords: motivation, contextual factors; perceived behavioural control; attitude; subjective norms

Introduction

In children and adolescents (hereafter referred as young people) with cerebral palsy (CP), engaging in physical activity (PA) is essential for improving quality of life, psychological well-being, and functional capacity (Demuth et al., 2012; Maher et al., 2007; Wright et al., 2019). Despite these benefits, young people with CP often participate in less PA than their typically developing peers, a disparity attributed to motor function barriers and environmental factors, including social and attitudinal aspects (Carlon et al., 2013; Gharib et al., 2021; Longo et al., 2020; Mihaylov et al., 2004). Recent studies emphasize the significant influence of environmental factors, particularly parental support, in encouraging PA among young people with CP (Bloemen, Backx et al., 2017; Kowalchuk & Crompton, 2009; Laukkanen et al., 2020; Ruiz et al., 2021a; Siebert et al., 2017; Taylor et al., 2004).

Parental support emerges as a critical factor in the facilitation of PA in young people with CP (Björquist et al., 2019), mirroring its importance in the PA engagement of non-disabled youth (Gustafson & Rhodes, 2006; Parker et al., 2022; Sallis et al., 2000). For young people with disabilities, the role of parents as facilitators and role models is even more pronounced, significantly impacting their young people's participation in PA (Ruiz et al., 2021a; Taylor et al., 2004). However, a lack of parental support, potentially arising from factors such as limited knowledge, perceived barriers, or lack of resources, has been shown to contribute significantly to lower levels of PA in young people with CP (Carlon et al., 2013; Verschuren et al., 2007, 2016). The observed impact of both the presence and absence of parental support on the PA levels of young people with CP underscores the critical need to explore the motivational and attitudinal factors underpinning parental support for PA in young people with CP.

Addressing the identified need to understand the motivational and attitudinal drivers of parental support, this study adopts Ajzen's Theory of Planned Behaviour (TPB) (Ajzen, 1991; Ajzen, 2002) as our theoretical framework to explore the intentions of Finnish parents in supporting PA for their young people with CP. The TPB posits that behavioural intention, influenced by attitude (the individual's positive or negative evaluation of performing the behaviour), subjective norms (the perceived social pressure to engage or not engage in the behaviour), and perceived behavioural control (PBC) (the individual's perceived ease or difficulty in performing the behaviour, which is assumed to reflect past experience and anticipated impediments and obstacles), is a primary predictor of behaviour (Azjen, 1991).

In this context, focusing on parental intentions is crucial because they serve as the immediate precursors to behaviour within the TPB framework (Ajzen, 1991). Since measuring actual supportive behaviours was beyond the scope of our cross-sectional design, the present study's core aim is to examine the determinants of parental intention, as predicted by the TPB. By identifying the factors that shape parental intentions, we seek to enhance understanding in this area, which may inform future interventions aimed at translating these intentions into supportive actions and ultimately enhancing PA participation among young people with CP (Hamilton et al., 2020; Ruiz et al., 2021a).

Applying this framework, we sought to identify the motivational factors driving parents' intentions to facilitate PA engagement in their young people with CP. This approach addresses a significant gap in the research, by enhancing our understanding of the factors that influence parental intentions to support PA in young people with CP, providing a basis for future studies to explore how these insights can inform the design of effective interventions.

By integrating insights from recent studies (Bloemen, Backx et al., 2017; Kowalchuk & Crompton, 2009; Laukkanen et al., 2020; Ruiz et al., 2021a; Siebert et al., 2017; Taylor et al., 2004) and employing a Bayesian methodology, we aimed to assess the likelihood and implications of various factors affecting parental support for PA in young people with CP. Adopting a Bayesian analytical framework represents a methodological shift from traditional frequentist statistics. Bayesian approach offers significant advantages in situations involving complex variables and limited data (Kruschke & Liddell, 2018). It provides probabilistic interpretations of model parameters, enabling a comprehensive and flexible inference process (Gelman et al., 2013; Kruschke, 2014). This approach is particularly suitable for exploring the dynamics of parental support for PA in young people with CP, where factors are interrelated and data may be constrained (Daniels & Hogan, 2008; Valadão et al., 2021). Contrary to frequentist methods, which emphasize p-values and confidence intervals, Bayesian analysis incorporates prior beliefs and uncertainties, offering a more holistic evaluation of the likelihood of various hypotheses (Gelman & Shalizi, 2013; Van de Schoot et al., 2021). This shift in methodology aligns with recent advancements in

statistical analysis, particularly relevant in social science research where behavioural patterns exhibit considerable complexity and diversity (Gelman et al., 2013; Kruschke, 2014). Ultimately, this study contributes to the development of more tailored and effective interventions to promote PA in young people with CP, addressing a critical need in this field.

This study aims to investigate the intention of Finnish parents in supporting PA for their young people with CP, utilizing Ajzen's TPB (Ajzen, 1991; Ajzen, 2002) as the theoretical framework. Specifically, it is hypothesized that parental intention to support PA in young people with CP will be influenced by attitude, subjective norms, and PBC.

Materials and Methods

This study employs a cross-sectional design to analyze the factors associated with parental intention to support PA engagement among Finnish youth with CP. The cross-sectional approach allowed us to assess the associations between the TPB constructs and parental intention to support at a single point in time.

This study recruited parents of young individuals who participated in the Exercises for CP (EXECP) intervention (further details provided in the following EXECP Intervention Details section). In total, 24 parents were invited to participate, with data ultimately collected from 16 parents. Eight parents declined to complete the questionnaire or did not return it to the research team. The survey instruments were distributed to parents in a paper format for completion at their residences, along with detailed instructions. Additionally, parents were afforded the opportunity to seek assistance from a member of the research team for any inquiries related to the survey.

EXECP intervention details

The EXECP intervention explored the effects of tailored exercise therapy on PA, neuromuscular mechanisms, and cardiometabolic risk factors in Finnish young people with CP (Valadão et al., 2021, 2024). The research protocol was approved by the Central Finland Hospital District ethics committee (04/2017). Informed consent was obtained from each participant and family member participating in the study. Participants in the EXECP intervention were young individuals aged between 9 and 21 years (mean age 14.70 years, SD = 4.86) diagnosed with spastic hemiplegia or diplegia-type CP and classified according to the Gross Motor Function Classification System (GMFCS; Alshryda & Wright, 2014) levels I to III. Recruitment criteria were stringent to ensure a relevant participant group, with exclusion criteria including significant medical interventions affecting motor function in the six months prior to the study and participation in other strength training programs within the same period.

While the EXECP intervention is not the primary focus of our study, a detailed description is crucial for contextualizing our analysis within its broader framework and for ensuring transparency, despite data collection being limited to the baseline of the intervention. This information offers insight into the selection criteria employed within the EXECP intervention and ensures transparency throughout the recruitment process for our study.

Survey Measures

In this current study, the survey measures were grounded in the TPB. The survey comprised multi-item measures for key TPB constructs: intention, attitude, subjective norms, and PBC. Each construct was quantified using a 7-point Likert scale, ensuring a detailed and comprehensive assessment of each construct. Intention was assessed using three items, each designed to measure the parent's intention to encourage their child to engage in more PA over the next 6 months. Examples of questions included 'I am determined

to encourage my child to engage in more physical activity during the next 6 months,' with response options ranging from 'Definitely' to 'Definitely not.' Attitude was evaluated using six items, with questions such as 'For me to encourage my child to engage in physical activity during the next 6 months is good,' with response options ranging from 'Very good' to 'Very bad'. Subjective norms were measured through six items, including statements like 'My family-friends believe that I have to encourage my child to engage in more physical activity.' Response options ranged from 'Very much agree' to 'Very much disagree.' PBC was assessed using three items, including 'I am absolutely sure that I will encourage my child to engage in more physical activity during the next 6 months.' Response options ranged from 'Absolutely certain' to 'Absolutely uncertain.' In the analysis, responses to the items within each construct were averaged to create a composite score for that construct. Before averaging, all items were coded such that higher scores indicated a stronger presence of the construct (e.g., more positive attitudes, greater perceived behavioral control). Any negatively worded items were reverse-coded accordingly. This consistent approach ensured that each construct was represented by a single, interpretable value. These combined variables were then used in subsequent analyses within a Bayesian framework. The reliability of these measures was robust, as indicated by Cronbach's alpha values: attitude = .82, subjective norms (SN) = .80, PBC = .84, and intention = .97. Each of these values surpasses the accepted threshold of .70 for reliability (Field, 2013; Hair et al., 2009), underscoring the internal consistency of our survey instruments.

Sample Size

In our Bayesian analysis, the determination of sample size aimed to ensure the precision and reliability of our posterior estimates while remaining feasible within practical constraints, including the availability of participants and logistical resources. Unlike traditional statistical methods where sample size is often driven by power calculations, Bayesian analysis emphasizes the precision of posterior estimates, which is influenced by the size of the sample. Our objective was to gather a sample large enough to ensure that our Bayesian estimates were precise and reliable, yet feasible within the practical constraints of our study.

To achieve this goal, we conducted sensitivity analyses and posterior predictive checks using computational simulations to assess the impact of sample size on the precision and stability of our estimates, as detailed in the "Validity and Reliability in Bayesian Analysis" section. Specifically, we varied the sample size (e.g., ±20%) and default prior distributions in our simulation-based tests. The results indicated that the posterior estimates for each TPB construct (attitude, subjective norms, and PBC) remained stable across these scenarios, suggesting that the chosen sample size was adequate for the purposes of our study.

Bayesian analytical framework

This study employs a Bayesian approach within a cross-sectional design to analyze the factors associated with parental intention to support PA engagement among Finnish youth with cerebral palsy (CP). The Bayesian methodology, distinct from traditional frequentist methods, is typically used to integrate prior knowledge with new observations. However, given the absence of specific prior data within our study population, we employed standard non-informative priors provided by JASP, a statistical software designed for Bayesian analysis (JASP Team, 2023; Version 0.18.1.0). These priors exert minimal influence, allowing the empirical data to primarily guide the analysis and ensure robust, data driven findings (Gelman et al., 2013; Kruschke, 2014). This approach enabled us to explore the dynamics of parental intention to support PA engagement among Finnish youth with CP in a rigorous and principled manner.

The Bayesian methodology was selected due to its flexibility and capacity to provide detailed insights into the relationships between variables, which is particularly valuable in contexts with smaller sample sizes. Unlike traditional methods that rely on large sample theory, Bayesian methods can yield more robust estimates even with limited data.

Diagnostic Checks for Regression Analysis

Prior to conducting the Bayesian regression analysis, we performed diagnostic checks to ensure the appropriateness of the model and the data. Specifically, we assessed multicollinearity among predictors using Pearson correlations and variance inflation factors (VIFs) (Craney & Surles, 2002; Mason & Perreault, 1991). While the Bayesian framework is generally robust to multicollinearity, extreme multicollinearity can still affect the estimates. Our analysis did not reveal any issues with multicollinearity.

To assess the assumptions of homoscedasticity and linearity within the Bayesian context, we conducted posterior predictive checks and examined posterior predictive residuals (Gelman et al., 2013; Gabry et al., 2019). Posterior predictive checks involve generating simulated data from the posterior distribution and comparing it to the observed data to evaluate model fit and detect any potential deviations from model assumptions. The examination of posterior predictive residuals indicated that our model adequately captured the relationships in the data, and no significant violations of homoscedasticity or linearity were detected. These findings suggest that the data and model are appropriate for Bayesian regression analysis.

Regression Analysis of TPB Constructs

The software's correlation module in JASP streamlined the computation of Pearson correlation coefficients and their corresponding Bayes Factors (BF_{10}). These factors are crucial for evaluating the strength and significance of relationships between TPB constructs, providing evidence by comparing the likelihood of data under models where the constructs are interdependent versus independent. A higher BF_{10} indicates stronger evidence for a relationship. Additionally, the regression module in JASP was pivotal for our Bayesian regression analysis. It enabled us to estimate the probability of model parameters using posterior distributions. This module also included credible intervals, offering a more informative alternative to traditional null hypothesis significance testing. This allowed for a detailed probabilistic interpretation of the associations between TPB constructs and parental intentions.

Model Comparison for Predictors of Parental Intention

To identify the most effective predictors of parental intention to support PA in young people with CP, we conducted a comprehensive Bayesian model comparison using JASP. This analysis integrated various combinations of the TPB constructs—Attitude, Subjective Norms, and PBC. Each model's effectiveness was assessed based on its posterior probability given the data, Bayes Factors (BF_{10}) in comparison to the null model, and the proportion of variance explained (R^2).

JASP's capabilities were pivotal in facilitating this complex model comparison. The software computed posterior probabilities, Bayes Factors (BF_{10}), and explained variance for each TPB construct combination. We used JASP's default beta-binomial model prior, which assigned prior probabilities of 0.250 to both the null model and the full model (including Attitude, Subjective Norms, and PBC), while each of the other models received a prior probability of 0.0833. This approach reflects a balanced consideration of model complexity, giving equal prior weight to the simplest model and the most complex model, with lower prior probabilities assigned to intermediate models. This setting aimed to provide a comprehensive assessment of each model's strength relative to both the baseline hypothesis

and the full model. This approach ensures that our conclusions about the predictors are robust and empirically grounded.

Standard Prior in Bayesian Analysis

In Bayesian statistics, the sample size is part of a larger context that includes prior information. However, given the absence of specific prior data pertinent to our study variables, standard priors were employed as part of the analysis methodology. Standard priors, alternatively known as default or non-informative priors, are frequently utilized when prior information from previous studies or domain expertise is lacking. These priors are deliberately selected to exert minimal influence on the posterior estimates, thereby allowing the observed data to primarily guide the analyses. The utilization of standard priors ensures that our Bayesian analysis remains fundamentally data-driven, prioritizing the influence of observed data on the posterior distributions. Integration of standard priors preserves transparency and methodological rigor, facilitating a comprehensive interpretation of results grounded solely in available data (Gelman & Shalizi, 2013). By incorporating standard priors within our Bayesian framework, the authors of this study uphold a principled approach to statistical inference, enabling insightful interpretations of the data while effectively addressing uncertainties inherent in the analysis process.

Interpretation of Results

Utilizing a Bayesian framework provides a comprehensive understanding of the data on parental intention to support PA among young people with CP, enhancing traditional statistical analysis. In our study, posterior distributions, which form the cornerstone of Bayesian statistics, encapsulated the probabilities of our model parameters by integrating prior knowledge with new empirical data. This integration updated and refined our understanding of the relationships between TPB constructs and parental intention to support, enhancing the accuracy and relevance of our findings.

Interpreting these distributions involves assessing a range of possible values for each parameter and determining their likelihood. Unlike conventional statistical methods that often result in dichotomous conclusions, Bayesian analysis provides a continuum of probabilities. This method enables us to present our findings in terms of probability ranges, such as credible intervals, which articulate the level of certainty we have regarding our estimates.

In our study, this approach is particularly valuable for examining the intricate interplay of determinants shaping parental intention to support PA among young people with CP. Our findings are discussed not just in terms of the presence or absence of associations, but in terms of the likelihood and strength of these associations. To provide more specific guidance on the strength of evidence, we adopt the following criteria for interpreting Bayes Factors (BF_{10}) based on the JASP guidelines for conducting and reporting a Bayesian analysis (van Doorn et al., 2021):

- Bayes Factor (BF_{10}) between 1 and 3: Weak evidence in favor of the presence of an association.
- Bayes Factor (BF_{10}) between 3 and 10: Moderate evidence in favor of the presence of an association.
- Bayes Factor (BF_{10}) greater than 10: Strong evidence in favor of the presence of an association.

Additionally, Bayesian analysis aids in evaluating the evidence for different hypotheses concerning parental intention to support PA for young people with CP. This evaluation considers varying levels of impact and likelihood, offering a more layered and detailed understanding than traditional statistical tests.

Through this detailed interpretation of Bayesian results, our study aims to provide in-depth insights into the complex dynamics of parental intention to support young people´s PA. The results are presented not just in statistical terms, but also in a manner that conveys the practical significance and real-world implications of our findings.

Validity and Reliability in Bayesian Analysis

In our study, ensuring the validity and reliability of the Bayesian analysis was a crucial aspect of our methodology. We employed several steps within the Bayesian framework to achieve this:

1. Model Credibility: We critically assessed how well our Bayesian model represented the complexities of parental intention to support for PA in young people with CP, evaluating the model's assumptions and its alignment with the collected data (Gelman et al., 2013).
2. Convergence and Representativeness in Bayesian Analysis: We ensured convergence and representativeness through the analytical tools provided by JASP, verifying the stability and consistency of our Bayesian estimates (Kruschke, 2014).
3. Sensitivity Analysis: We conducted sensitivity analyses and computational simulations to assess the impact of prior distributions and sample size on our results. Specifically, we varied the sample size in simulated datasets to observe its effect on the precision and stability of the posterior estimates. This process helped confirm that our findings were robust across a range of plausible sample sizes and not overly dependent on specific prior assumptions (Saltelli et al., 2008).
4. Posterior Predictive Checks: We performed posterior predictive checks to evaluate the predictive accuracy of our model, comparing generated predictions against actual observed data (Gelman & Shalizi, 2013).

These measures collectively underpinned the validity and reliability of our Bayesian analysis, providing credible and robust insights into the factors influencing parental intention to support PA among Finnish young people with CP.

Handling of Missing Data

During data collection, 2.4% of the data points were missing. Handling missing data effectively is crucial in maintaining the integrity and validity of statistical analyses, particularly in a Bayesian framework (Daniels & Hogan, 2008). Unlike traditional imputation methods, which fill in missing values based on observed data, our Bayesian approach treats missing data as additional parameters to be estimated. This method is more aligned with the principles of Bayesian inference and offers a coherent way to handle uncertainties in the data (Little & Rubin, 2002; Rubin, 2004).

In practice, this approach involves defining a model for the complete data and then integrating over the unknown values. By doing so, the researchers of this study effectively utilize the known data to inform estimates of the missing points, incorporating the uncertainty associated with these estimates directly into our analysis. It is important to note that this method assumes the data are missing at random (MAR), meaning that the likelihood of a data point being missing is related to observable data but not to the value of the missing data itself. It's a crucial assumption because if missingness is related to the unobserved data, our estimates could be biased. In response to the challenge of missing data, we employed JASP software for Bayesian analysis. JASP facilitates Bayesian treatment of missing data and incorporates uncertainty due to missingness directly into parameter estimates and predictions (van de Schoot et al., 2021). This integration is essential for Bayesian analysis, providing a more comprehensive understanding of the data while accounting for inherent uncertainty.

It is important to note that while the MAR assumption is a standard approach in handling missing data, it does have its limitations. Specifically, if the missingness of data is related to unobserved variables, this could potentially bias our results (Little & Rubin, 2019). To mitigate this risk, we conducted sensitivity analyses to compare the effects of different missing data handling techniques (e.g., pairwise deletion versus listwise deletion) on our results. These analyses were vital for ensuring that our conclusions about parental intentions to support PA were robust and not unduly influenced by how missing data was treated. This approach allowed us to confirm that the MAR assumption did not bias our findings significantly. To interpret the significance of any differences observed, we adopted Cohen's (1988) criteria for effect sizes, where differences in correlation coefficients smaller than 0.1 are generally considered to be small and therefore not of substantive practical significance. By conducting sensitivity analyses, we aimed to ensure that our conclusions were robust and not unduly influenced by the missing data.

Results

A total of 16 parents of young people with CP were included in the analysis. The descriptive statistics of our dataset (Table 1) provided essential details on the distribution of responses for the TPB constructs. These statistics offer a detailed view of the data, showcasing the central tendencies and variabilities within our sample.

Table 1. Descriptive statistics of the Theory of Planned Behaviour constructs.

Variable	N	Range	Median	Min.	Max.	IQR	Mean	SD
Attitude	16	3.33	6.33	3.66	7.00	2.33	5.75	1.15
Subjective norms	16	5.00	4.75	2.00	7.00	1.25	5.29	1.31
Perceived behavioural control	16	4.33	6.33	2.66	7.00	1.33	6.10	1.10
Intention	16	3.66	7.00	3.33	7.00	0.33	6.47	1.11

IQR = Interquartile Range; SD = Standard deviation

A Bayesian correlation analysis was carried out to evaluate the interrelations among the TPB constructs: intention, attitude, subjective norms, and PBC. Correlation analyses were conducted using combined variables, which aggregated responses from multiple items measuring each construct. The results of the analysis are summarized in Table 2, which illustrates the correlations among these constructs along with corresponding Bayes Factors (BF_{10}).

Table 2. Bayesian Pearson Correlations.

Variable	1. Intention				2. Attitude				3. Subjective Norms			
	r	BF_{10}	UCrI	LCrI	r	BF_{10}	UCrI	LCrI	r	BF_{10}	UCrl	LCrI
1. Intention	—											
2. Attitude	.84**	533.81	0.94	0.52	—							
3. Subjective Norms	.31	0.57	0.66	-0.21	.42	1.04	0.72	-0.10	—			
4. Perceived Behavioural Control	.86**	585.42	0.95	0.54	.93**	31361.21	0.98	0.73	.42	0.88	0.72	0.14

Pearson's r: Pearson correlation coefficient, indicating the strength and direction of the linear relationship between two variables. **BF_{10}**: Bayes Factor (BF) provides a ratio of the probability of the data under one hypothesis compared to another. A BF_{10} greater than 10 suggests strong evidence in favor of the alternative hypothesis, while a BF_{10} close to 1 indicates that the evidence is not conclusive. **UCrI and LCrI**: Upper and lower bounds of the 95% credible interval for the correlation coefficient. $BF_{10} > 10$ indicates strong evidence for the alternative hypothesis. ** $BF_{10} > 30$ indicates very strong evidence for the alternative hypothesis.

Sensitivity Analysis for Missing Data

A sensitivity analysis compared correlation coefficients using two distinct methods of handling missing data. The results are summarized in Table 3.

Table 3. Comparison of correlation coefficients between pairwise and listwise deletion methods.

Variable Pair	Pairwise deletion	Listwise deletion	Difference
Attitude - Subjective norms	.421	.441	-.020
Attitude – Perceived Behavioural Control	.933	.933	.000
Attitude - Intention	.837	.844	-.007
Subjective Norms – Perceived Behavioural Control	.402	.402	.000
Subjective Norms – Intention	.306	.362	- .056
Perceived Behavioural Control – Intention	.857	.857	.000

Note: The table compares correlation coefficients obtained using pairwise and listwise deletion methods for handling missing data. The minimal differences observed indicate that the method of handling missing data does not significantly impact the relationships between the variables, thereby reinforcing the robustness and reliability of the results.

Bayesian Model Comparison for factors associated with parental intention

To identify the most effective predictors of parental intention to support PA in young people with CP, we conducted a Bayesian model comparison. The results of the model comparison are presented in Table 4, which displays the computed metrics for each model under consideration. These metrics provide insight into which TPB constructs, either individually or in combination, are most predictive of parental intention to support their young people´s PA engagement.

Table 4. Model Comparison-Intention.

Models	P(M)	P(M|data)	BFM	BF10	R^2
Perceived Behavioural Control	.08	.38	6.63	1.00	.73
Attitude	.08	0.24	3.52	0.64	.71
Attitude + Perceived Behavioural control	.08	0.12	1.49	0.32	.75
Attitude + Subjective Norms + Perceived Behavioural Control	.25	0.11	.36	.10	.75
Subjective Norms + Perceived Behavioural Control	.08	.09	1.08	.24	.73
Attitude + Subjective Norms	.08	.06	.71	.16	.71
Null model	.25	.003	.009	.003	<.001
Subjective Norms	.08	<.001	.009	.002	.13

P(M): Prior model probability, representing the prior belief about the likelihood of each model being correct. **P(M|data)**: Posterior model probability updated after observing the data, indicating the revised belief about the likelihood of each model being correct. **BFM**: Bayes Factor for model comparison, quantifies the change in odds favoring a specific model over all other models, comparing the model's posterior odds to its prior odds. A BFM greater than 1 indicates that the data have increased the support for the model relative to all other models. **BF10**: Bayes Factor comparing each model to the null model, quantifies the strength of evidence in favor of each model relative to the null model (which contains no predictors). A BF_{10} greater than 1 suggests that the data provide more support for the model than for the null model. **R^2**: Proportion of variance explained by each model. The table 4 indicates the performance of each model in the Bayesian framework, with the model including only PBC as the predictor showing the highest posterior probability and Bayes Factor relative to the null model.

Posterior Summaries of Coefficients for TPB Constructs

Our Bayesian regression analysis provided posterior distributions for each of the coefficients in the model. The posterior summaries in Table 5 include the mean, standard deviation (SD), and a 95% credible interval for each coefficient, reflecting the central tendency and dispersion of the estimates.

The 'Intercept' represents the expected value of parental intention when all TPB constructs are at their reference level (usually zero). The posterior mean of the intercept is 6.467, indicating a generally high intention to support PA among parents, with a narrow credible interval ([6.130, 6.831]), suggesting high certainty around this estimate.

Table 5. Posterior summaries of coefficient.

Variable	P(incl)	P(excl)	P(incl|data)	P(excl|data)	BFinclusion	Mean	SD	LCrI	UCrI
Intercept	.99	.00	.99	<.001	1.00	6.47	0.16	6.13	6.83
Attitude	.50	.50	.53	.47	1.13	0.37	0.47	-0.04	1.39
Subjective Norms	.50	.50	.25	.74	0.35	0.001	0.09	-0.31	0.17
Perceived Behavioural Control	.50	.50	.69	.31	2.26	0.47	0.40	0.00	1.14

The intercept is a parameter that represents the expected value of the dependent variable when all the independent variables (attitude, subjective norms and PBC) are set to zero. **P(incl)**: Prior inclusion probability, indicating the prior belief about the relevance of each predictor. **P(excl)**: Prior exclusion probability, indicating the prior belief about the irrelevance of each predictor. **P(incl|data)**: Posterior inclusion probability, updated after observing the data, suggesting the relevance of each predictor. **P(excl|data)**: Posterior exclusion probability, updated after observing the data, suggesting the irrelevance of each predictor. **BF inclusion**: Bayes Factor for inclusion, quantifying the strength of evidence for including a predictor in the model. **Mean**: The posterior mean of the coefficient, representing the central estimate of the effect. **SD**: Standard Deviation of the posterior distribution, indicating the dispersion or uncertainty around the estimate. **LCrI**: Lower bound of the 95% credible interval. **UCrI**: Upper bound of the 95% credible interval.

Discussion

Our study's primary finding is the potential association of PBC with parental intention to support PA in young people with CP, while observing limited associations for attitudes and subjective norms. This conclusion is supported by our Bayesian regression analysis. Specifically, for PBC, the inclusion probability increased from 0.50 to 0.69, indicating a meaningful update in our belief about its relevance. The Bayes factor (BF_{10}) suggested that the data provided more than twice the evidence in favor of including PBC as a predictor compared to excluding it. In contrast, attitudes showed a minimal increase in inclusion probability from 0.50 to 0.53, with the BF_{10} indicating only anecdotal evidence for its relevance. Subjective norms exhibited a decrease in inclusion probability from 0.50 to 0.26, and the BF_{10} provided weak evidence against its inclusion as a significant predictor. Although there was a noticeable change in the inclusion probability for subjective norms, the associated BF_{10} suggests that the data did not provide strong support for its relevance.

To the best of our knowledge, there are no prior studies specifically exploring parental intention to support their young people's PA. Previous studies employing the TPB have typically focused on predicting individuals' own intentions towards PA, where PBC often plays a crucial role, followed by attitudes, with subjective norms contributing less significantly (Hagger et al., 2002; McEachan et al., 2011; Rhodes et al., 2006). This pattern is observed across various populations, suggesting a generally consistent association between PBC and intentions (Hagger et al., 2002; McEachan et al., 2011). However, it is important to note that these associations can still vary among different groups and contexts (Hagger et al., 2002; Hamilton et al., 2020). By incorporating Bayesian methodologies and empirical data, our research extends the contributions of Shields et al. (2012), Bloemen, Van Wely et al. (2017), and Verschuren et al. (2016). It provides initial insights into the potential dynamics of parental intention to promote PA for youth with CP, highlighting the need for interventions to prioritize enhancing parental PBC for effectively supporting PA among young people with CP. In the following sections, we will delve deeper into the associations of PBC, attitudes, and subjective norms with parental intentions, explore the underlying factors influencing these associations, and discuss the implications for intervention design.

Perceived Behavioural Control and parental intention association

The potential association of PBC with parental intention to support PA in young people with CP aligns with prior research which indicates an association between PBC and intention towards PA across diverse populations, encompassing both individuals with and without disabilities (Hagger et al., 2002; Ku & Jin, 2022). This key result not only corroborates but also expands the application of Ajzen's TPB (Ajzen, 1991) in the context of disability and PA

(Sur et al., 2022). However, it is essential to interpret this finding with caution, considering the uncertainty indicated by the credible interval that includes zero.

Moreover, while PBC shows a potential association with parental intentions, it is important to recognize that intentions do not always translate into behaviour. Research has documented the intention-behaviour gap in PA, where strong intentions may not lead to corresponding actions (Feil et al., 2023; Rhodes & de Bruijn, 2013). In family-based interventions, Rhodes et al. (2021) found that incorporating planning and habit constructs into the TPB framework enhanced the prediction of actual PA behaviour. This suggests that beyond PBC, additional factors like planning and habit formation may be necessary to bridge the intention-behaviour gap.

Previous research consistently suggested that PBC has a substantial association with intentions across diverse populations in the PA domain (Hagger et al., 2002). While attitudes and subjective norms also contribute to intention, their impact may vary across populations. Studies by Ku and Jin (2022) and Brown et al. (2020) provide valuable insights into the role of TPB constructs within populations affected by disabilities, including individuals with CP. These studies highlight the importance of PBC in driving intentions among individuals with disabilities. Notably, the pronounced role of PBC emphasizes the significance of parental efficacy and control perceptions in facilitating PA, consistent with previous findings (Shields et al., 2012; Taylor et al., 2004).

The marked potential association of PBC with shaping parental intention to support PA warrants a deeper exploration of its underlying causes. One primary reason for PBC's dominance may be rooted in the unique challenges that parents of young people with CP face, which directly impact their perceived control over supporting PA. These challenges include navigating complex healthcare systems, managing daily care routines, and addressing the specific physical and psychological needs of their young people. Such obstacles can affect parents' confidence and perceived ability to facilitate PA, either by limiting their resources and opportunities or by motivating them to overcome these barriers. Research by Rentinck et al. (2009) has highlighted these aspects, emphasizing the multifaceted responsibilities borne by parents of young people with disabilities.

Furthermore, Davis et al. (2009) investigated the quality of life of parents with young people who have CP and observed that these parents often feel unsupported by the services they access. This perceived lack of support can lead to increased parental stress and may compel parents to assert greater control over various aspects of their young person’s life, including physical activities, as a compensatory mechanism. Although Davis and colleagues primarily focused on overall quality of life, their findings imply that inadequate support systems might inadvertently enhance parents' PBC, as they are forced to adapt to manage their young person’s needs in the face of these challenges.

Another contributing factor could be the societal and environmental barriers encountered by these families. Parents may feel that their ability to control or influence these external factors is limited, thus focusing more on aspects they perceive as within their control, such as creating supportive home environments or seeking appropriate resources. Studies by King et al. (2003) and Murphy et al. (2007) support this view, illustrating how environmental factors significantly impact the participation of young people with disabilities in various activities.

Moreover, the emphasis on PBC could also be reflective of the psychological coping strategies adopted by parents. According to research by Shikako-Thomas et al. (2008), parents often develop adaptive coping mechanisms to manage the stresses associated with raising a young person with CP. This might involve focusing on areas where they feel more competent and in control, aligning with the concept of self-efficacy as proposed by Bandura (1997). The concept of PBC in this context extends beyond merely facilitating PA, it

encapsulates the broader psychological resilience that enables parents to handle their caregiving responsibilities effectively. This resilience is often fostered by a sense of competence, which emerges when parents believe they can exert control over the challenges they face. Such a belief aligns with Bandura's (1997) notion of self-efficacy, which posits that the perception of being able to execute actions successfully is a critical component of effective coping strategies. In practice, when parents feel competent to manage or even ameliorate their young person's condition through personal action, they are more likely to engage in proactive behaviours that can lead to successful outcomes. This can include seeking out appropriate resources, advocating for their young person's needs, or implementing daily routines that accommodate their young person's unique challenges. The feeling of being in control, therefore, does not merely stem from successful actions but from the belief in their ability to affect change, which is a key aspect of PBC. Thus, enhancing PBC among parents could significantly influence not only their intention to support their young person's PA but also their overall well-being and capacity to cope with the demands of parenting a young person with CP.

Thus, while PBC's prominence in our study is consistent with Ajzen's TPB framework, it is also shaped by a complex interplay of personal, environmental, and societal factors unique to families of young people with CP. Acknowledging this complexity is crucial for developing interventions that address not just parental attitudes and norms, but also the real-world challenges they face in supporting their young people's PA.

Attitude and parental intention association

In our study, the association between attitude with parental intention to support PA in young people with CP was strong. However, when we controlled for other variables in the Bayesian regression analysis, the association between attitude and parental intention showed a large credible interval that included zero, indicating uncertainty regarding its unique contribution. This suggests that although parents may have favourable attitudes toward PA, these attitudes do not consistently translate into a strong intention to support PA. This implies that while attitudes are an essential component of the TPB, their role in this specific context might be less influential compared to the role of PBC or even subjective norms.

Previous research has established that attitudes can significantly influence behavioural intentions (Ajzen, 1991). However, in the context of parents of young people with CP, the translation of positive attitudes into intentions may be complicated by numerous factors. For instance, practical barriers such as limited access to appropriate facilities, lack of inclusive programs, and the physical and psychological demands of caring for a young person with CP could mitigate the impact of positive attitudes on intentions. Shields et al. (2012) and Taylor et al. (2004) note that these practical challenges often hinder parents from acting on their positive attitudes towards their child's PA.

Additionally, the role of external support systems cannot be underestimated. Parents with positive attitudes toward PA may still require substantial support to overcome the barriers they face. The integration of comprehensive support systems, including accessible facilities, professional guidance, and community programs, is crucial to enabling parents to act on their positive attitudes. Research by Verschuren et al. (2007) indicates that when these supports are in place, parents are more likely to translate positive attitudes into active support for their young person's PA.

In light of these findings, it is crucial for interventions to not only foster positive attitudes but also address the practical barriers that parents face. Enhancing parental access to resources, providing necessary support and information, and creating a more inclusive environment for PA can help bridge the gap between positive attitudes and intentions. By

addressing both attitudinal and practical barriers, future interventions may better support parents in their efforts to promote PA among their young people with CP.

Subjective norms and parental intention association

In this study the association between subjective norms and parental intention to support PA in young people with CP was relatively weak. Furthermore, when we controlled for other variables in the Bayesian regression analysis, the association between subjective norms and parental intention showed a decrease in inclusion probability from 0.50 to 0.26, and a Bayes Factor for inclusion (BF inclusion) of 0.349, providing weak evidence agrainst its relevance as a predictor. This indicates that subjective norms may not significantly influence parental intention in this context, and parents may prioritize their direct experiences and perceived control over societal influences. These findings align with previous literature emphasizing personal conviction and direct experience in parental decision-making for young people with disabilities (Rimmer et al., 2004; Shields et al., 2012). Additionally, the limited impact of subjective norms may relate to overprotective parental beliefs concerning disability (Bloemen et al., 2017a). Such beliefs might lead parents to prioritize safety and protection over PA, thus diminishing the influence of societal expectations on their intentions. This shift suggests a need for more targeted and empathetic support systems that align with the lived experiences of families with young people with CP.

Implications for intervention design

Our findings could contribute to intervention design in the following ways: Understanding that PBC may play a crucial role in parental intention to support, interventions should focus on empowering parents with the knowledge and resources to facilitate their young person's PA effectively. This approach resonates with studies by Ruiz et al., (2021), which highlight the importance of environmental facilitators and parental attitudes in promoting PA among young people with CP. Specifically, promoting adherence to home-based strength-training programs can enhance parents' perceived control by providing them with structured activities they can manage within the home environment, thereby increasing their confidence in facilitating their child's PA. As emphasized by Taylor et al. (2004), adherence to these programs is paramount, underlining the significant role of parental involvement in such initiatives. Home-based strength-training programs are indeed a common recommendation for young people with CP (Dodd et al., 2003), as they offer tailored exercises to improve strength and mobility in a familiar environment. By acknowledging this critical aspect, interventions can support parents in becoming effective facilitators of their young people's PA.

Furthermore, integrating planning and habit formation into interventions can enhance the translation of parental intentions into actual supportive behaviours, as indicated by Rhodes et al. (2021). By helping parents develop concrete plans and establish supportive habits, interventions may more effectively promote sustained PA engagement among young people with CP.

Our Bayesian interpretation of the TPB emphasizes the need for interventions that enhance parental perceived efficacy and offer a more adaptable perspective for enhancing parental support. The variability observed in the association between attitudes and parental intention, along with the limited influence of subjective norms, underscores the importance of flexibility in intervention design. By recognizing that parents' direct experiences and perceived control are more influential than societal norms, future interventions should be adaptable to address the unique challenges faced by each family. Interventions that are flexible and personalized can better support parents by catering to their specific

circumstances and needs, thereby enhancing their perceived efficacy and intention to support their young person's PA.

Our study's findings highlight the significant role of parental PBC in influencing parental intention to support PA in young people with CP. By focusing on Finnish parents and employing Bayesian analysis, we provide valuable insights that can inform future research and interventions. Replicating our study in more diverse cultural contexts will enhance the generalizability of these findings. Additionally, exploring how interventions that enhance parental PBC affect the actual PA levels of young people with CP is a vital area for further investigation. Such research will enrich our understanding and support the development of more effective, culturally sensitive interventions to promote sustained PA engagement among young people with CP, ultimately contributing to their overall well-being and quality of life. Future interventions should consider the following components to harness the potential of parental support:

Active Parental Involvement

Our study suggests that when parents feel more capable and confident in facilitating PA (i.e., higher PBC), their intention to support increases. Interventions should take parents as active participants from the design phase to tailor the intervention to their young people's needs, ensuring that it aligns with their preferences and capabilities. Previous research has shown that parental intention regarding PA support are associated with PBC (Ajzen, 1991; Hagger et al., 2002). By involving parents actively, interventions can capitalize on their PBC and efficacy, increasing the likelihood of successful implementation.

Sustained Support

The high levels of parental intention observed in our study indicate that parents are motivated to support their young people's PA. Future research should explore how PA initiated during an intervention can be sustained over time with the ongoing support of motivated parents, ensuring that the benefits are long-lasting. Studies have indicated that parental support and encouragement are essential for maintaining young people's PA levels over time (Shields et al., 2012; Ruiz et al., 2021a). By enhancing parents' intention and perceived control over supporting their young people's PA, interventions can foster sustained engagement and long-term adherence.

Tailored Approach

Given the significant role of PBC identified in our study, interventions should be personalized to enhance parents' sense of control over facilitating PA. Parents should be taught how to facilitate PA based on their own interests and preferences. This personalized approach aims to ensure that interventions resonate effectively with both parents and their young people with CP, potentially fostering a more sustainable engagement in PA. Research has shown that tailoring interventions to individual preferences and capabilities can enhance PBC and increase the likelihood of behaviour change (Hagger et al., 2002; Ruiz et al., 2021b). By empowering parents to adapt PA strategies to fit their unique circumstances, interventions can promote sustained participation and positive outcomes.

These components may empower parents to play a more active and effective role in promoting PA among young people with CP, ultimately contributing to their overall well-being and quality of life.

In summary, our study significantly contributes to the understanding of factors influencing parental intention to support PA in young people with CP, with a particular emphasis on the role of PBC. The findings underscore the importance of empowering parents with the confidence and resources necessary to facilitate PA, highlighting the central

role of PBC in determining parental intention. This insight is pivotal for designing effective interventions tailored to the unique challenges faced by families of young people with CP.

Methodological strengths and contextual insights

The use of Bayesian analysis in our study represents a significant methodological strength. This approach allowed us to incorporate prior knowledge and empirical data in a more integrative and informative way than traditional statistical methods. By utilizing Bayesian methods, we were able to provide probabilistic interpretations of our findings, which is particularly beneficial in fields like rehabilitation science where data can be complex and sample sizes are often smaller (Gelman et al., 2012; McNeish, 2016).

Furthermore, our study's integration of Bayesian methodology with the TPB framework is a novel approach that enhances the traditional use of TPB in health behaviour research. As Ajzen (2002) notes, TPB has been predominantly applied using frequentist statistical methods, which may not fully capture the uncertainty and variability inherent in behavioural research. Our Bayesian approach addresses this gap, providing a more robust and deeper understanding of the predictors of parental support for PA in young people with CP. This innovative application not only bolsters the validity of our findings but also contributes to advancing methodological practices in the field of health behaviour research.

Another key strength of our study is its focus on a specific, yet under-researched, population: Finnish parents of young people with cerebral palsy. This specificity allowed for a deeper exploration of the TPB constructs within a distinct cultural and healthcare context, contributing valuable insights to the global understanding of PA promotion in this demographic. In Finland, cultural attitudes towards PA are influenced by factors such as the country's strong emphasis on outdoor recreation and its tradition of promoting an active lifestyle from a young age. Additionally, Finland's healthcare system is characterized by its universal coverage and emphasis on preventive care, which may impact parents' perceptions of their role in promoting young people´s PA. The cultural context is especially important as it shapes parental beliefs and attitudes, a point underscored by Hofstede (2001) in his work on cultural dimensions and their impact on behaviour. These specific aspects of Finnish culture and healthcare may result in findings that could differ in other countries where the emphasis on outdoor activities and preventive healthcare may not be as strong. Therefore, while our findings provide valuable insights, they should be interpreted with caution when considering different cultural and healthcare contexts.

In summary, the methodological rigor and innovative application of Bayesian analysis, combined with a focused examination of a specific population, stand as major strengths of our study.

Study limitations

Our study has several limitations that warrant acknowledgment. First, the authors of this study did not measure the actual supportive behaviours of parents or track changes in the PA levels of the young people with CP. This omission limits our ability to assess whether the intention reported by parents translated into real world actions. The intention-behaviour gap is well documented in PA research, indicating that strong intentions do not always lead to corresponding behaviours (Feil et al., 2023; Rhodes & de Bruijn, 2013). This gap suggests that while the TPB effectively predicts intentions, it may be less reliable in forecasting actual behaviours without considering additional factors such as habit formation and action planning (Rhodes et al., 2021).

Second, our sample was drawn from parents whose children participated in the EXECP intervention. The parents may have developed favorable attitudes and intentions toward promoting PA prior to launching the present study, given their willingness to enroll in a

tailored exercise program. Thus, we cannot fully exclude the possibility of selection bias. Therefore, the generalizability of our findings to parents of young people with CP who might not seek or accept such interventions may be limited.

Third, we did not explore parental beliefs such as anticipated regret, which Hamilton et al. (2017) identified as influential in supporting PA in young individuals without disabilities. Furthermore, the absence of demographic data, specifically the gender distribution of participants and their ages, restricts our ability to understand how diverse parental demographics might influence support for PA. This oversight highlights a critical gap in our research methodology and is an area targeted for enhancement in future studies. The use of a non-standardized questionnaire to collect data poses a potential limitation, as it may introduce variability in responses and affect the reliability and validity of the findings. The small sample size, subjectivity in selecting Bayesian priors, reliance on self-reported data, and the cross-sectional nature of our study also present challenges, as noted in the literature by Spiegelhalter et al. (1996) and Siebert et al. (2017).

Although standard priors offer a pragmatic solution in the absence of specific prior information, it is essential to acknowledge their inherent limitations and potential impact on analysis outcomes. To address this, we conducted sensitivity analyses to evaluate the influence of standard priors on our results. Additionally, we performed robustness checks on other aspects of our Bayesian analysis, such as model convergence and predictive accuracy, thereby ensuring the reliability and validity of our findings.

Perspectives

This research, by examining parental intention to support PA in young people with CP through a Bayesian lens, adds a significant layer to the discourse on adapted physical activity. As highlighted in previous literature (e.g., Bloemen et al, 2017a; Bloemen et al., 2017b; Taylor et al., 2004), understanding the factors that influence PA in this population is crucial for effective intervention design. Our findings reinforce the pivotal role of PBC, aligning with and expanding upon the insights offered by Ruiz et al. (2021a) and Mitchell et al. (2015). The emphasis on a Bayesian approach allows for a more in-depth understanding of the complexities involved in fostering PA among young people with CP, a perspective that is gaining traction in contemporary research (Laukkanen et al., 2020). The implications of this study are noteworthy for practitioners, as they underscore the need for more tailored interventions that address the specific challenges and motivations of parents. By integrating these insights into practice, there is potential for a meaningful impact on the promotion of PA in young people with CP, contributing to their overall well-being and quality of life. This research and its implications offer a promising pathway for future studies in the field of adapted physical activity

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Author Contributions: Conceptualization, T.F., K.N. and A.R.; Methodology, T.F., K.N. and A.R.; Analysis, A.R.; Writing-Original Draft Preparation, K.N., T.F., K.K., P.R. and A.R.; Writing-Review & Editing, T.F., K.N., K.K., P.R and A.R..

Funding: This study was part of the EXECP project, which received funding from the Ministry of Education and Culture (OKM/28/626/2022; T. Finni). In addition, this specific study received financial support from the Urheiluopistosäätiö (20200213).

Availability of data and materials: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical reasons.

Acknowledgments: The authors would like to thank Pedro F. Valadao for support during data gathering, and Professor Maria Chassandra for her contribution of developing the TPB questionnaire used in this study.

Conflicts of Interest: The authors declare no conflict of interest.

Reviewers: This paper underwent an open review with thanks to Mohammed Khudair and Nicola McCullogh as peer reviewers. Read more about open review policy for editors of EUJAPA https://eujapa.upol.cz/artkey/inf-990000-0400_Author-Guidelines.php

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