Correlates of Mental Health in Adolescents and Young Adults with Cerebral Palsy: A Cross-Sectional Analysis of the MyStory Project

Jan Willem Gorter 1,2, *, Darcy Fehlings 2,3, Mark A. Ferro 2,4, Andrea Gonzalez 5, Amanda D. Green 1,2, Sarah N. Hopmans 1,2, Dayle McCauley 2,*, Robert J. Palisano 2, Peter Rosenbaum 1,2, Brittany Speller 1,2 and on behalf of the MyStory Study Group †

Abstract: Background: It is important to gain a better understanding of mental health issues in adolescents and young adults (AYA) with cerebral palsy (CP). In this cross-sectional study, we explore if demographics, social and clinical questionnaire scores, and cortisol levels in hair samples from AYA with CP are associated with higher scores on anxiety and/or depression questionnaires. Methods: Data from a community-based sample of 63 AYA with CP (30 females; ages 16 to 30 (median age of 25)) were analyzed. Forty-one (65%) participants (20 females) provided a hair sample. Outcomes were assessed using bivariate linear regression analyses and hierarchical regression analyses. Results: Clinical depressive and anxiety symptoms were present in 33% and 31% of participants, respectively. Family functioning, $B = 9.62$ (95%CI: 5.49–13.74), fatigue, $B = 0.15$ (95%CI: 0.05–0.25), and pain, $B = 1.53$ (95%CI: 0.48–2.58) were statistically significant predictors of depressive symptoms. Fatigue, $B = 0.24$ (95%CI: 0.12–0.35) and pain, $B = 1.63$ (95%CI: 0.33–2.94) were statistically significant predictors of anxiety. Cortisol levels from hair samples were not found to be associated with depressive symptoms or anxiety. Conclusions: A high prevalence of mental health problems and co-occurring physical problems was found in AYA with CP. Integrating mental support into regular care for AYA with CP is recommended.

Keywords: mental health; anxiety; depression; cerebral palsy; adolescence; young adults

1. Introduction

There is an increasing movement in the clinical community to re-frame our understanding of disabilities, such as cerebral palsy (CP), as childhood-onset disorders rather than disorders of childhood. Children with CP can expect a longer life span due to medical advances, but they are also more likely to require ongoing supports and services as they age beyond what is required for their typically developing peers [1–5]. Young adults with CP can face challenges with aspects of health and wellness, education, employment, accessible housing, and social relationships. Compared to peers without disabilities, adolescents and young adults (AYA) with CP often report lower employment rates, are less likely to
participate in leisure/social activities or pursue post-secondary education, and often are more dependent on their families for living arrangements [3,6–8]. Additional challenges include a lack of access to health care; professionals’ lack of knowledge of CP; and lack of information and uncertainty regarding the transition to adulthood process [3,7,9,10].

Chronic health conditions (CHC), including CP, can increase the risk of developing problems related to mental health, chronic pain, and fatigue [9,11–18]. Further, stress, chronic pain, and mental health issues are highly comorbid in patients with CHCs [11,15,19], and this co-morbidity may worsen an individual’s outcomes [20]. Most youth mental health studies include a range of CHCs, including epilepsy and juvenile diabetes. However, young adults with physical disabilities have higher scores on depression and anxiety symptoms than those with other CHCs [16,21,22]. Most relevant for the current purpose, one study observed a four-fold increase in the prevalence of emotional disorders in children with CP between seven and eleven-years of age [23] and a systematic review has suggested that children and adolescents with CP may be at an increased risk of developing mental health problems [24]. Indeed, mental illness was the third most common reason for hospital admissions in young adults with CP [21], and recent large database studies have elucidated both a higher prevalence and risk of mental health disorders among adults with CP compared to the general population [17,18]. Given the high prevalence of mental health disorders and comparatively lower frequency of check-ups in this population, many AYA who would benefit from interventions may go unnoticed or treated.

The review [24] further highlights many gaps in the literature, including a reliance on parent-reports for mental health symptoms and an under-reporting of rates of mental health issues in older-adolescent or young adult age groups [24]. CP is one of the most common neurodevelopmental disorders (2 in 1000 live births) and can occur alongside other cognitive and behavioural issues, including autism spectrum disorder, attention deficit hyperactivity disorder (ADHD), and anxiety disorders [8,19,25]. This highlights a need for more targeted research into the mental health of these AYA [24,26]. In this spirit, the current study was conducted to examine the psychosocial and biological correlates of mental health in AYA with CP.

To ease the transition from adolescence into adulthood for AYA with CP, it is important to gain a better understanding of the self-reported prevalence of mental health issues, including symptoms of anxiety and depression. Further, there are important gaps in our understanding of physical and psychosocial factors that might contribute to the development of mental health issues in AYA with CP, either as markers of vulnerability or as co-morbid issues that might aggravate symptoms. The “MyStory” project is a study within the Childhood Cerebral Palsy Integrated Neuroscience Discovery Network (CP-NET) coordinated by CanChild, McMaster University. The project is a longitudinal study investigating the course of physical health, mental health and well-being in AYA with CP. This project includes yearly screening questionnaires on fatigue, pain, anxiety, depression, family functioning, quality of life, and also investigates neurophysiological factors, including changes in stress hormones (cortisol levels). Hair cortisol has been used as a biomarker of hypothalamic–pituitary–adrenal axis activity, and exposure to systemic cortisol over time. It has been associated with a variety of conditions, including changes in mental and physical health, early life trauma, ADHD, worker burnout, and anxiety or depression in different age groups [27–34]. To date, however, no research has explored the use of hair cortisol as a biomarker for mental or physical health in AYA with CP. In this study, we explore cross-sectionally some of the initial relationships discovered in the Year 1 data, including prevalence rates of anxiety and depressive symptoms, and association of demographics (age, gender, gross motor function level), social (family functioning) and clinical (pain, fatigue) questionnaire scores, on anxiety and depression questionnaire scores. We will also begin to investigate relationships between anxiety and depression questionnaire scores and hair cortisol levels.
2. Materials and Methods

2.1. Study Design, Setting and Participants

A sample of AYA (ages 16 to 30) was recruited through CanChild at McMaster University using a variety of methods (posters, recruitment letters, emails). Recruitment strategies included mailing or emailing recruitment letters to individuals who previously participated in CanChild research projects, mailing recruitment letters to eligible participants through a Children’s Treatment Centre in Windsor, Ontario, in clinic recruitment at hospitals across Ontario (St. Catharines, Toronto, London, and Hamilton), and organizations supporting people with disabilities sharing the recruitment poster to their communities.

The MyStory project is designed as a quantitative, longitudinal study (though the data subset for this study design is cross-sectional), where participants complete a series of questionnaires and provide hair samples at the same time. All participants completed the Year 1 questionnaires between 2014–2018. Participants participated in the study voluntarily and had the option to complete as many Year 1 questionnaires as desired. Participants were still eligible to participate and complete questionnaires if they declined to provide a hair sample. Participants needed to meet the following criteria to be included in the study: (1) be between the ages of 16 and 30; (2) have a confirmed diagnosis of CP in childhood; (3) reside in Ontario, Canada at registration; (4) be capable of consenting to participation; (5) be able to complete online questionnaires (alone or with assistance); and (6) be able to follow simple instructions.

All aspects of this study were approved by the Hamilton Integrated Research Ethics Board, and recruitment materials at external sites were approved by their relevant ethics boards. All study personnel who had contact with any participants received suicide risk assessment training via the Columbia Suicide Severity Scale (C-SSRS) training module [35]. Should a participant report thoughts of death or suicide, a standardized follow-up protocol was observed including provision of and/or contacting resources and caregivers.

2.2. Patient and Public Involvement

We designed the study based on clinical experiences and the needs expressed by AYA with CP and their families. The Ontario Federation for Cerebral Palsy, a non-profit organization in Ontario that supports people with CP, has been involved since study conception and are key partners in the MyStory study. During the data collection of the MyStory study, participants expressed a desire to share their experiences more broadly and participated in knowledge dissemination activities such as webinars (www.cp-net.org, accessed on 1 April 2022).

2.3. Data Collection and Instruments

Demographic characteristics, including age and gender, and gross motor function were collected from participants. Participants completed the self-reported questionnaires online or by paper and pencil at their homes, by themselves or with the assistance of a family member or peer. Participants’ functional capabilities were determined using decision-making questions around major life issues (who decides daily activities and how spending money is used) and daily routine issues (who decides what is eaten, what is done for fun, and the time for bed).

The description of questionnaires are as follows (See Table 1 for summary).

2.3.1. State-Trait Anxiety Inventory (STAI)

A 40-item questionnaire based on a 1 to 4 Likert scale. The STAI measures two types of anxiety: state anxiety (S-Anxiety), or anxiety about an event, and trait anxiety (T-Anxiety), or anxiety level as a personal characteristic [36]. The MyStory study asked participants the S-Anxiety questions allowing for understanding on how participants were feeling at the time they completed the questionnaire across time points to better detect longitudinal change [37]. An overall score for S-Anxiety is calculated as a total sum, ranging from 20 to 80, with a higher score indicating greater anxiety. Scores equaling or higher than 40
are thought to suggest possible clinical anxiety [36]. We did not score the S-Anxiety scale if more than 10% of data were missing [38]. The S-Anxiety scale has high internal consistency (α = 0.86–0.95) [36].

2.3.2. Center for Epidemiological Studies Depression Scale (CES-D)

A 20-item self-report instrument that evaluates depressive symptoms defined by the American Psychiatric Association Diagnostic and Statistical Manual (DSM-IV) for a major depressive episode [39]. Participants respond on a 4-point Likert scale, where higher scores indicate higher levels of depression. The overall score for the CES-D is calculated as a total sum, ranging from 0 to 60. Individuals with questionnaire scores equaling 16 or higher are considered to be demonstrating possible clinical depressive symptoms [40,41]. We did not score the CES-D scale when more than four questions were missing following developer guidelines. The CES-D scale has adequate test–retest reliability (0.45–0.70) and high internal consistency (α = 0.85–0.90) [39].

2.3.3. McMaster Family Assessment Device (FAD)

The updated 60-item questionnaire evaluates families on the dimensions of the McMaster Model of Family Functioning [42]. Following the instructions of the questionnaire, youth defined what family meant to them. The questionnaire includes sub-scales on problem solving, communication, roles, affective response, affective involvement, behaviour control and general functioning. This study used the ‘general functioning’ sub-scale to capture the overall level of family functioning. The general functioning sub-scale contains 12 items to assess overall family health, such as making decisions and feelings of acceptance within the family [42]. Responses are measured on a 4-point Likert scale from 1, indicating strongly agree, to 4, indicating strongly disagree. Total scores are calculated as an average of the 12 items ranging from 1, indicating “best functioning”, and 4, indicating “worse functioning” of the family [42,43]. Problematic family functioning is present when individuals score 2.00 or higher in the general functioning sub-scale. We did not score the sub-scale if more than 40% of responses were missing [42]. The FAD general functioning sub-scale has adequate test–retest reliability (0.71) and high internal consistency (α = 0.92) [43].

2.3.4. Fatigue Impact and Severity Self-Assessment (FISSA)

This 37-item fatigue questionnaire allows participants to respond to 30 questions on a 5-point Likert scale (higher scores indicate greater fatigue) and 6 open-ended questions on the impact, severity, and management of experienced fatigue [44]. One question allows participants to respond to a 7-point Likert scale to account for the number of days each week fatigue is experienced. This study used the score for the 31 questions using Likert scale responses, which are used to index the level of fatigue in terms of impact and severity, calculated as a total sum for the fatigue level, with scores ranging from 31 (less fatigue) to 157 (more fatigue). The FISSA was not scored if more than 10% of data were missing [38]. This questionnaire was designed specifically for individuals with CP and has high internal consistency (α = 0.95) and adequate test–retest reliability (0.75) [44].

2.3.5. Pain

This scale, developed by researchers at CanChild, evaluates pain severity and location [45]. It initially asked participants if they had experienced physical pain in the past month. If they responded ‘yes’, then they were asked the severity of pain and if the pain got in the way of their daily activities on a 10-point Likert scale. The scale then asked participants to indicate the body regions where they had experienced pain. For this study, we calculated the number of painful sites reported by participants as a total sum, as this was the critical measure used in the study that developed this scale [45]. Scores ranged from 0 to 10, with higher scores indicating more painful body sites. We excluded any questionnaires with missing data.
2.3.6. Gross Motor Function Classification System (GMFCS)

Participants functional status was collected using the Gross Motor Function Classification System that categorizes physical abilities on a 5-level scale: Level I—walks without restrictions; Level II—walks without assistive devices but has limitations walking in community and outdoors; Level III—walks with assistive mobility devices and has limitations walking in community and outdoors; Level IV—self-mobility with limitations, may use power mobility devices in the community and outdoors; and Level V—self-mobility with severe limitations even when using assistive technology [46].

2.4. Hair Samples

Participants provided hair samples to assess cortisol levels. Hair cortisol analysis is an emerging biomarker for chronic stress, as systemic cortisol is understood to be incorporated into the hair shaft during hair growth [47]. Participants, with the assistance of a researcher or a family member/friend, provided a hair sample (approx. 3 mm in diameter—50 to 80 strands) from the posterior vertex of the head, and cut as close to the scalp as possible. Studies have demonstrated that hair cortisol levels are positively correlated with measures of perceived stress [30,32,47,48] and permit the retroactive assessment of cortisol for at least three months [49–51]. Along with the hair samples, participants completed a biological questionnaire to collect information on current medications, chemical treatments to hair, smoke exposure, and ethnicity, among other factors. Hair samples were assayed using a validated ELISA protocol to determine concentrations of cortisol in the sample (picogram (pg)/milligram (mg)). The ELISA protocol is outlined in Appendix A.

Table 1. Variables included in the dataset.

| Measure                                      | Type           | Number of Items | Constructs Examined                      |
|----------------------------------------------|----------------|-----------------|------------------------------------------|
| Age (years)                                  | Continuous     | 1               | Demographics                             |
| Gender (male, female)                        | Binary         | 1               | Demographics                             |
| Gross Motor Functional Classification System (GMFCS) | Ordinal        | 1               | Gross motor function level               |
| State-Trait Anxiety Inventory (STAI), State Anxiety (S-Anxiety) | Continuous * | 20              | State Anxiety Present; State Anxiety Absent |
| Center for Epidemiological Studies Depression Scale (CES-D) | Continuous * | 20              | Negative Affect; Positive Affect; Anhedonia; Somatic Symptoms |
| McMaster Family Assessment Device (FAD), General Functioning Sub-Scale | Continuous * | 12              | General Functioning; Overall Level of Family Functioning |
| Fatigue Impact and Severity Self-Assessment Tool (FISSA) | Continuous * | 31              | Impact of Fatigue on Daily Living; Fatigue Management and Activity Modification |
| Pain                                          | Continuous     | 10              | Number of Painful Body Sites             |

* Classifying scores on Likert-scale questionnaires as continuous is somewhat disputed, but variables will be treated as continuous for this project [52].

2.5. Statistical Analyses

All of the surveys were scored according to the individual survey instructions, including instruction around missing data. Descriptive statistics are reported based on the spread and central tendencies of variables. For each outcome (depression and anxiety, respectively) we completed bivariate linear regression analyses to determine if one or more of our demographic variables (age, gender, GMFCS), scores on questionnaires (FAD, FISSA, pain), or cortisol levels were associated with higher scores on either (A) the CES-D depression scale, or (B) the S-Anxiety scale. We also completed hierarchical regression analyses with CES-D and S-Anxiety and included predictor variables in four blocks: (1) Demographics—age, gender (reference is female), GMFCS (reference is Level 1); (2) Social—FAD; (3) Clinical—
FISSA, pain; and (4) Biological—cortisol levels. All dependent variables were assessed for normality and linearity. All statistical tests were performed as two-tailed, and a statistically significant effect was observed at a \( p \leq 0.05 \) with 95% confidence intervals. All statistical analyses were performed using SPSS 25.

3. Results

Of the 70 AYA with CP that provided consent to participate in this study, 63 (90%) participants completed at least one questionnaire (FAD, FISSA, CES-D, S-Anxiety, or pain) in Year 1. Of the 37 participants (58%) who completed the GMFCS questionnaire, 14 (38%) identified as Level I; 6 (16%) identified as Level II; 6 (16%) identified as Level III; 10 (27%) identified as Level IV; and 1 (3%) identified as Level V. Most participants decided major life issues and their daily routine alone or in partnership with someone else (Table 2).

Table 2. Participant functional capabilities.

| Variable          | n  | Decides Alone (%) | Decides with Someone Else (%) | Someone Else Decides (%) |
|-------------------|----|-------------------|-------------------------------|--------------------------|
| Daily activity    | 53 | 36 (68%)          | 16 (30%)                      | 1 (2%)                   |
| Use of spending money | 53 | 34 (64%)          | 17 (32%)                      | 2 (4%)                   |
| What is eaten     | 52 | 30 (58%)          | 19 (36%)                      | 3 (6%)                   |
| What is done for fun | 52 | 39 (75%)          | 13 (25%)                      | 0 (0%)                   |
| Time for bed      | 52 | 43 (83%)          | 8 (15%)                       | 1 (2%)                   |

Participants who completed at least one questionnaire included 30 (48%) females and 33 (52%) males with a median age of 25 (IQR 23.00–27.00). Among those who completed questionnaires, 51 participants (81%) completed five questionnaires (FAD, FISSA, CES-D, S-Anxiety, pain). Baseline descriptive characteristics, including median questionnaire scores, and the number of participants who completed each questionnaire, are provided in Table 3. We collected 47 hair samples from individuals at the first time point. One individual provided a hair sample, but did not complete any of the questionnaires included in this analysis. Three hair samples could not be processed due to insufficient weight, and two hair samples were removed from our analysis as outliers, resulting in 41/63 (65%) hair samples available (20 females, 21 males).

Table 3. Descriptive characteristics of baseline variables.

| Variable       | n   | Data Missing (n) | Median (1st Quartile, 3rd Quartile) | Mean | Standard Deviation | Min, Max |
|----------------|-----|------------------|-------------------------------------|------|--------------------|---------|
| Age (years)    | 63  | -                | 25.00 (23.00, 27.00)                 | 24.46| 3.30               | 16.00, 29.00 |
| STAI           | 58  | 5                | 32.00 (25.00, 43.00)                 | 34.96| 12.09              | 20.00, 64.00 |
| CESD           | 61  | 2                | 9.00 (4.00, 17.50)                   | 12.54| 10.67              | 0.00, 46.00 |
| FAD            | 61  | 2                | 1.82 (1.45, 2.45)                    | 1.89 | 0.58               | 1.00, 3.27  |
| FISSA          | 59  | 4                | 88.00 (67.00, 105.00)                | 85.69| 24.61              | 33.00, 141.00 |
| Pain           | 57  | 6                | 2.00 (1.00, 5.00)                    | 2.89 | 2.389              | 0.00, 9.00  |
| Cortisol (ng/mL) | 41 | 22               | 4.22 (2.89, 5.88)                   | 5.09 | 3.87               | 0.33, 20.19 |

Note: As variables were not normally distributed, the median, 1st quartile, and 3rd quartile were reported. The FISSA was normally distributed and Mean and SD (Standard Deviation) were reported. FISSA = Fatigue Impact and Severity Self-Assessment, Pain = Painful Body Sites, FAD = Family Assessment Device, General Functioning Sub-Scale, CESD = Center for Epidemiological Studies Depression Scale, STAI = State-Trait Anxiety Inventory, State Anxiety Scale, Cortisol = Hair cortisol concentration (pg/mg). Data missing = number of data points excluded from analysis due to missing data.
In our samples, 20/61 (33%) of participants had CES-D questionnaire scores equal to or higher than 16, indicative of possible clinical depressive symptoms. Similarly, among participants who completed the S-Anxiety Scale, 18/58 (31%) of participants had a score higher than 40, suggesting possible clinical anxiety. Among the 56 participants who completed both the CES-D and S-Anxiety Scale, 10 participants (18%) scored higher than the cut-offs on both measures, indicating possible clinical depressive symptoms and anxiety. Additionally, among participants who completed the FAD ‘general functioning’ sub-scale, 25/61 (41%) scored 2.00 or above suggesting unhealthy overall level of family functioning.

3.1. Correlates of Depression

3.1.1. Bivariate Regression Analysis: CES-D

Bivariate regression analyses examined the relationship between age, gender, GMFCS, family functioning (FAD) scores, fatigue (FISSA), pain, and cortisol as predictors of CES-D score. Using regression diagnostics for each analyses, we removed one data point from all analyses that had high residuals. Removal of these data points did not influence the significance of the independent variables.

FAD was statistically significant, $R^2 = 0.28$, $F (1, 56) = 21.80$, $p < 0.001$, Adj $R^2 = 0.27$, indicating around 27% of CES-D variation was predicted by family functioning. FISSA was statistically significant, $R^2 = 0.15$, $F (1, 54) = 9.63$, $p = 0.003$, Adj $R^2 = 0.14$, indicating around 14% of CES-D variation was predicted by FISSA scores. Pain was also statistically significant, $R^2 = 0.14$, $F (1, 53) = 8.575$, $p = 0.005$, Adj $R^2 = 0.12$, indicating around 12% of CES-D variation was predicted by total number of painful body sites. All effect sizes are small according to Cohen’s $d$ [53]. Regression coefficients and standard errors are in Table 4.

3.1.2. Hierarchical Regression Analysis: CES-D

We examined the relationship between demographic (age, gender, GMFCS), social (FAD), clinical (FISSA, pain), and biological (cortisol levels) predictors of CES-D using a hierarchical regression. Using regression diagnostics, we identified one data point that had high leverage and residual, and it was removed from the model.

The first two models that added demographic and social variables were not statistically significant. The addition of clinical variables made the model statistically significant with the predictor variables accounting for around 41.6% variation in CES-D. The final model with all variables including cortisol was statistically significant accounting for...
approximately 62.9% variation in CES-D scores. This is a medium effect size according to Cohen’s d [53]. Regression coefficients and standard errors are presented in Table 5.

Table 5. Hierarchical regression model summary—CES-D.

| Characteristics | Step 1                      | Step 2                      | Step 3                      | Step 4                      |
|-----------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Demographics    |                             |                             |                             |                             |
| Age             | −0.07 (−1.25, 1.11)         | −0.01 (−1.21, 1.19)         | −0.22 (−1.31, 0.88)         | −1.20 (−2.40, −0.00)        |
| Male Gender     | −3.48 (−11.47, 4.51)        | −2.21 (−10.84, 6.42)        | −10.24 (−19.36, −1.12)      | −6.16 (−14.25, 1.93)        |
| GMFCS 2         | 0.70 (−17.09, 18.48)        | 1.09 (−16.94, 19.13)        | −10.09 (−26.90, 6.72)       | −12.13 (−25.80, 1.54)       |
| GMFCS 3         | 7.59 (−2.99, 18.16)         | 7.91 (−2.83, 18.64)         | 0.90 (−12.22, 14.03)        | 4.81 (−6.26, 15.89)         |
| GMFCS 4         | 0.23 (−8.47, 8.94)          | 2.21 (−7.76, 12.19)         | −6.20 (−17.19, 4.79)        | −2.80 (−12.11, 6.51)        |
| GMFCS 5         | 17.63 (−0.19, 35.46)        | 17.69 (−0.37, 35.75)        | 8.06 (−8.22, 24.33)         | 19.21 (3.17, 35.24)         |
| Social          |                             |                             |                             |                             |
| FAD             | 3.34 (−4.51, 11.19)         | −7.78 (−18.05, 2.50)        | −9.78 (−18.24, −1.33)       |                             |
| Clinical        |                             |                             |                             |                             |
| FISSA           |                             |                             |                             |                             |
| Pain            |                             |                             |                             |                             |
| Biological      |                             |                             |                             |                             |
| Cortisol        |                             |                             |                             |                             |
| Model Fit       |                             |                             |                             |                             |

Note: Results are presented as unstandardized regression coefficients and associated 95% confidence intervals. CES-D = Center for Epidemiological Studies Depression Scale, FAD = Family Assessment Device, General Functioning Sub-Scale, FISSA = Fatigue Impact and Severity Self-Assessment, Pain = Painful Body Sites, GMFCS = Gross Motor Function Classification System, Cortisol = Hair cortisol.

3.2. Correlates of Anxiety

3.2.1. Bivariate Regression Analysis: S-Anxiety

Bivariate regression analyses examined the relationship between age, gender, GMFCS, family functioning (FAD) scores, fatigue (FISSA), pain, and cortisol as predictors of S-Anxiety score. FISSA was statistically significant, $R^2 = 0.23$, $F(1, 55) = 16.74$, $p < 0.001$, Adj $R^2 = 0.22$, indicating around 22% of S-Anxiety variation was predicted by FISSA scores. Pain was statistically significant, $R^2 = 0.10$, $F(1, 55) = 6.26$, $p = 0.015$, Adj $R^2 = 0.09$, indicating around 9% of S-Anxiety variation was predicted by total number of painful body sites. All effect sizes are small according to Cohen’s d [53]. When compared to GMFCS Level 1, participants with GMFCS Level 3 were statistically significant, $p = 0.033$. Regression coefficients and standard errors are in Table 6. As seen in Table 6, all statistically significant variables had positive regression weights.

3.2.2. Hierarchical Regression Analysis: S-Anxiety

We examined the relationship between demographic (age, gender, GMFCS), social (FAD), clinical (FISSA, pain), and biological (cortisol levels) predictors of S-Anxiety using a hierarchical regression. Using regression diagnostics, we identified one data point that had high residual, and it was removed from the model.

The second model that included demographic and social predictor variables was statistically significant accounting for around 38.7% of variation in S-Anxiety scores. No other models were statistically significant. Regression coefficients and standard errors are in Table 7.
Table 6. Summary of regression models—predictors of S-Anxiety scores.

| Variable                | n   | B     | SE_b  | ß    | 95%CI          |
|-------------------------|-----|-------|-------|------|--------------|
| Age                     | 58  | −0.26 | 0.49  | −0.07| −1.25–0.73    |
| Male                    | 58  | −2.87 | 3.19  | −0.12| −9.26–3.52    |
| GMFCS Level 2           | 36  | 4.80  | 5.62  | 0.15 | −6.65–16.25   |
| GMFCS Level 3           | 36  | 11.83 | 5.26  | 0.41 | 1.11–22.56    |
| GMFCS Level 4           | 36  | 4.00  | 4.46  | 0.17 | −5.10–13.10   |
| GMFCS Level 5           | 36  | 3.00  | 11.16 | 0.05 | −19.76–25.76  |
| FAD                     | 58  | 4.60  | 2.72  | 0.22 | −0.84–10.05   |
| FISSA                   | 57  | 0.24  | 0.06  | 0.48 | 0.12–0.35     |
| Pain                    | 57  | 1.63  | 0.65  | 0.32 | 0.33–2.94     |
| Cortisol                | 38  | 0.04  | 0.53  | 0.01 | −1.03–1.12    |

Note: B = unstandardized regression coefficient, SE_b = Standard Error of the coefficient; ß = standardized coefficient; CES-D = Center for Epidemiological Studies Depression Scale, FAD = Family Assessment Device, General Functioning Sub-Scale, FISSA = Fatigue Impact and Severity Self-Assessment, Pain = Painful Body Sites, GMFCS = Gross Motor Function Classification System, Cortisol = Hair cortisol.

Table 7. Hierarchical regression model summary—S-Anxiety.

| Characteristics | Step 1 | Step 2 | Step 3 | Step 4 |
|-----------------|--------|--------|--------|--------|
| Demographics    |        |        |        |        |
| Age             | −0.67  | −0.63  | −0.64  | −0.62  |
| Male Gender     | 3.44   | 4.67   | 1.34   | 1.17   |
| GMFCS 2         | −1.41  | 0.05   | −6.91  | −6.89  |
| GMFCS 3         | 15.17  | 15.52  | 10.55  | 10.39  |
| GMFCS 4         | 10.35  | 12.45  | 9.47   | 9.30   |
| GMFCS 5         | 6.92   | 7.58   | 1.26   | 0.91   |
| Social          |        |        |        |        |
| FAD             | 6.231  | 2.60   | 2.57   | 2.57   |
| Clinical        |        |        |        |        |
| FISSA           | 0.20   | 0.2    | 0.2    | 0.2    |
| Pain            | −0.92  | −0.92  | −0.92  | −0.92  |
| Biological      |        |        |        |        |
| Cortisol        | 0.04   | 0.04   | 0.04   | 0.04   |
| Model Fit       | 0.43   | 0.60   | 0.72   | 0.72   |

Note: Results are presented as unstandardized regression coefficients and associated 95% confidence intervals. CES-D = Center for Epidemiological Studies Depression Scale, FAD = Family Assessment Device, General Functioning Sub-Scale, FISSA = Fatigue Impact and Severity Self-Assessment, Pain = Painful Body Sites, GMFCS = Gross Motor Function Classification System, Cortisol = Hair cortisol.

4. Discussion and Conclusions

The cross-sectional (Year 1) data in the MyStory project indicates that family functioning (FAD), fatigue, and pain are statistically significant predictors of higher CES-D scores, suggesting that poorer overall family functioning, fatigue, and more painful body sites play a role in increased depressive symptoms in AYA with CP. Similarly, for the S-Anxiety, fatigue (FISSA) and pain were statistically significant positive predictors of anxiety scores, suggesting that fatigue and more painful body sites plays a role in increased anxiety symptoms. However, the effect sizes were small. The hierarchical regression analyses indicate
that demographic, social, clinical, and biological factors influence depressive symptoms in AYA with CP.

## 4.1. Mental Health and Cerebral Palsy

This study further substantiates that anxiety and depression are a substantial problem in AYA with CP [16–18]. The high prevalence of AYA with CP who scored above the cut-offs indicating possible clinical anxiety (31%) and depressive symptoms (33%) in this study is similar to findings in recent database studies from the United States and United Kingdom that used diagnostic codes to identify AYA with CP with formally diagnosed mental health disorders. Whitney et al. [17] found that 28.6% of women and 19.5% of men with CP had anxiety related or mood disorders. Smith et al. [18] found those with CP had an increased risk of developing anxiety (hazard ratio, 1.40; 95%CI, 1.21–1.63) and depression (hazard ratio, 1.43; 95%CI, 1.24–1.64) when compared to those without CP. This study included self-reported anxiety and depressive symptoms, which may account for the slightly higher prevalence when compared to studies using diagnostic codes. AYA with CP often do not receive a formal diagnosis of anxiety and/or depression or are considered to not have symptoms severe enough to receive a formal diagnosis. Those experiencing barriers to accessing mental health services describe losing hope as they have inadequate support and funding to assist them with their symptoms [54]. While the median age of participants in our study was 25 years of age, studies focusing on children and adolescents with CP have shown similar prevalence in anxiety and depression [16,19]. The accumulation of this research indicates that mental health issues, such as anxiety and depression, are present throughout the life course of individuals with CP.

A recent review highlighted that aging with CP can be accompanied by a myriad of new and changing neurologic symptoms including pain and fatigue, which are related to mental health conditions such as depression and anxiety [55]. Indeed, pain and fatigue are commonly reported in AYA with CP [56–59] and have been shown to be associated with depressive symptoms and mood (affective) disorders in adults with CP [60] and groups with other conditions [15,61]. This study supports these findings and finds those with more painful body sites also have higher depression scores. Pain can be debilitating and have a substantial impact on individuals’ daily functioning, ability to sleep, and quality of life [54,58]. Stress and anxiety has also been reported by AYA with CP as a contributing factor to fatigue [62].

Furthermore, positive family functioning and peer support are key factors that impact mental health [63]. This study found that over 40% of participants reported unhealthy overall family functioning and lower family functioning was a statistically significant predictor of higher depressive scores. We considered physical health (fatigue and pain) and social relationships (family functioning) in this study, but our models could only account for a small portion of the variation in anxiety and depressive scores. Other factors that could be considered in the future to explain the variation include measuring if AYA with CP have meaningful participation at work and in recreation activities, social isolation, and stress associated with school, work, peer relationships, managing finances, and making health care decisions [54]. A decline in social participation can also contribute to a decline in mental health [64].

This is the first study, to our knowledge, that explores the relationship between cortisol from hair samples and anxiety and depression symptoms in AYA with CP. While cortisol was not found to be a predictor of anxiety or depression, the sample size for the cortisol regression analyses only included 38 participants. Cortisol was a statistically significant unique predictor of depressive symptoms in the hierarchical regression model, however the model only included 21 participants with seven possible predictors, suggesting that we may have been nearing the limits of the predictive power of this model given our sample size. A larger sample size with additional hair samples would help us to address some of these shortcomings, and better address the question of whether cortisol is a useful biomarker for mental health in AYA with CP.
4.2. Recommendations for Healthcare System and Providers

Based on the findings from this study, clinicians may benefit from noting that AYA with CP who are reporting high levels of fatigue, more sites of pain, or appear to be having difficulties with their families, may be at a higher risk of developing a clinical anxiety or depressive disorder. Given our finding that around 30% of our sample experience clinically relevant levels of anxiety or depressive symptoms, this area of research is clearly deserving of more focus from the medical community. Integrating mental health services, such as screening tools [65] and timely referrals to mental health professionals, into regular follow up of AYA with CP is recommended due to this high prevalence.

Any mental health services should be sustained when adolescents with CP transition into adult care services (around the age of 18 in Ontario, Canada) well into young adulthood (age 30).

Indeed, a life course approach to care—which highlights the role of person-environment interactions as a key process by which health development occurs—encourages coordination and continuity of healthcare between family-centered service in pediatrics to an individual-centered environment in adult care [66]. This is especially important considering the added challenges surrounding lack of support, access and knowledge reported by AYA with CP during their transition between these two systems, and in turn the potential impact of these challenges on long-term health trajectory [67]. Further, this approach broadens the scope of environmental factors that contribute to health and encourages interventions that alleviate barriers to life experiences and social participation [66]. Indeed, initiatives including mindfulness-based stress reduction programs delivered virtually show promising benefits by educating and enhancing individuals ability to cope with their CP-related symptoms, such as pain and fatigue [68]. Social connectedness, acupuncture, massage, and leisure activities have also been reported to be helpful coping strategies for physical and mental health symptoms [54,69]. Additional strategies to manage family functioning, pain, and fatigue in AYA with CP tailored to the needs of the specific individual and utilizing different delivery methods may help mitigate some of their mental health issues.

4.3. Limitations and Future Directions

The subjective nature of the questionnaire responses allowed us to understand feelings and experiences directly from AYA with CP themselves. However, participants who were more open to sharing their experiences may have opted to participate in the study, thus introducing volunteer bias. Alternative approaches to creating our models may have included reducing our CES-D and S-Anxiety scores to dichotomous variables using the clinical cut-off points (“risk of clinical depression” vs. “lower risk of clinical depression” for example) and performing logistic regression analyses. In addition, though we removed outliers that were statistically different from the rest of our sample, we did not necessarily have a good ‘clinical’ reason to remove them, and they may have been valid data points. During Year 1 of the MyStory study, we did not collect the Trait Anxiety in the STAI. However, these data are being collected for participants continuing their involvement in the study to allow for further understanding of anxiety in AYA with CP. Future longitudinal analyses are planned for the MyStory study data (data collection is still ongoing) and will include a larger sample size across time points, allowing us to explore how levels of anxiety, fatigue, depression, family functioning, participation, self-management, and quality of life change across time. We also aim to understand if there are age effects to these changes across times to better identify the appropriate timing of strategy and resource implementation for AYA with CP.

Author Contributions: J.W.G. is the guarantor for the study. Conceptualization, J.W.G., D.F., M.A.F., D.M., R.J.P. and P.R.; data curation, A.G., S.N.H. and B.S.; formal analysis, A.G. and B.S.; funding acquisition, J.W.G.; methodology, J.W.G., D.F., M.A.F., D.M., R.J.P. and P.R.; project administration, S.N.H.; resources, A.D.G.; supervision, J.W.G. and D.M.; visualization, A.G., S.N.H. and B.S.; writing—original draft, J.W.G., A.G., D.M. and B.S.; writing—review and editing, D.F., M.A.F., S.N.H., R.J.P. and P.R. All authors participated in the interpretation of data, provided their final approval, and
contributed equally to this work. J.W.G. led the writing of the manuscript and is the lead author, and the other authors are listed in alphabetical order. All authors have read and agreed to the published version of the manuscript.

Funding: This research was conducted with the support of the Ontario Brain Institute, an independent nonprofit corporation, funded partially by the Ontario government. The opinions, results and conclusions are those of the authors and no endorsement by the Ontario Brain Institute is intended or should be inferred. This research also received partner contribution by the Scotiabank Chair in Child Health Research held by Jan Willem Gorter. The funders did not have any role in the study design, data collection, analyses, or manuscript preparation.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Hamilton Integrated Research Ethics Board (protocol code 13-840, 17 December 2013).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The Childhood Cerebral Palsy Integrated Neuroscience Discovery Network (CP-NET) is one Integrated Discovery Program funded by the Ontario Brain Institute. Data collected for studies within CP-NET, including the MyStory study, are added to Brain-CODE and will be accessible to external researchers through data access requests. Data specifically used in this study are available from the corresponding author upon reasonable request.

Acknowledgments: We gratefully acknowledge the adolescents and young adults with cerebral palsy who participated in the MyStory study (The following are members of the MyStory Study: Jan Willem Gorter (principal investigator); Geoff Hall, Peter Rosenbaum, Darcy Fehlings, Caitlin Cassidy, Mark Ferro, Andrea Gonzalez, Sidney Segalowitz, Anna McCormick, Robert Palisano, Leslie Atkinson (co-investigators); Christine Lackner, Diana Tajik-Parvinchi, Amanda Green (post-doctoral fellows); Sarah Hopmans, Dayle McCauley, Brittany Speller, Aya Dudin, Julie Wilson, Helena Viveiros, John Secen (research and project staff members); Andrew Davis (students)). The authors thank Samantha Dong and Randi Mao for updating the literature for this study. We also acknowledge and thank the recruiting clinicians: Paul Stacey, at Niagara Children’s Centre in St. Catharines, Caitlin Cassidy at St. Joseph’s London in London, and Andrea Lauzon and Mark Bailey at Toronto Rehabilitation Institute in Toronto. We acknowledge the contributions of Jessica Geboers, a Stakeholder Advisory Group member, for presenting and sharing the MyStory research study design and findings. We appreciate the continued partnership with the Ontario Federation of Cerebral Palsy in the MyStory study to recruit participants, plan, and support knowledge translation activities to the CP community.

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

Appendix A

Cortisol ELISA Protocol: After collection, samples were placed in sealed plastic bags and stored at room temperature until they were assayed. A standardized protocol was used to process hair samples. The first 3 cm of each hair sample (proximal to the scalp) was cut with scissors and placed into a Falcon 50 mL Conical Centrifuge Tube. Hair samples were washed twice with 12 mL of isopropanol while gently shaking samples by hand and then the isopropanol was discarded. Tubes were left open to air dry over 48 h. Using a Retsch CryoMill, dried samples were pulverized at 25 Hz for three minutes. Next, 30–35 mg of ground hair powder was measured and transferred to a 2 mL Eppendorf tube where 1 mL of 100% ethanol was added and shaken at 22 rpm on the RPI Mix-All Laboratory Tube Mixer for 24–72 h at room temperature. Samples were then vortexed for five seconds and centrifuged at 2800 rpm for 15 min after which, 0.8 mL of supernatant was aliquoted into a new 2 mL Eppendorf tube (supernatant tube). The supernatant was left to air dry for 48 h to ensure complete evaporation of the ethanol. Another 1 mL of 100% ethanol was added to the sample tube, and it was rotated at 22 rpm on the RPI Mix-All Laboratory Tube Mixer for 24–72 h at room temperature. Samples were vortexed for five seconds and centrifuged at 2800 rpm for 15 min. During this final extraction stage, 1 mL of the supernatant was aliquoted into the supernatant tube, and it was left to air dry for 48 h. The supernatant was reconstituted with 150 µL of Salimetrics Salivary Cortisol Assay Diluent,
References

1. Usuba, K.; Oddson, B.; Gauthier, A.; Young, N.L. Changes in gross motor function and health-related quality of life in adults with cerebral palsy: An 8-year follow-up study. Arch. Phys. Med. Rehabil. 2014, 95, 2071–2077.e1. [CrossRef] [PubMed]

2. Sienko, S.E. An exploratory study investigating the multidimensional factors impacting the health and well-being of young adults with cerebral palsy. Disabil. Rehabil. 2018, 40, 660–666. [CrossRef] [PubMed]

3. Oskouei, M.; Shevell, M.I. Cerebral palsy and the transition from pediatric to adult care. Contin. Lifelong Learn. Neurol. 2009, 15, 64–77. [CrossRef]

4. Bolger, A.; Vargas-Adams, J.; McMahon, M. Transition of care in adolescents with cerebral palsy: A survey of current practices. PM R 2017, 9, 258–264. [CrossRef] [PubMed]

5. Nguyen, T.; Henderson, D.; Stewart, D.; Ilyva, O.; Punthakee, Z.; Gorter, J. You never transition alone! Exploring the experiences of youth with chronic health conditions, parents and healthcare providers on self-management. Child Care Health Dev. 2016, 42, 464–472. [CrossRef]

6. Andersson, C.; Mattsson, E. Adults with cerebral palsy: A survey describing problems, needs, and resources, with special emphasis on locomotion. Dev. Med. Child Neurol. 2001, 43, 76–82. [CrossRef]

7. Nieuwenhuijsen, C.; Donkervoort, M.; Nieuwstraten, W.; Stam, H.J.; Roebroeck, M.E. Experienced problems of young adults with cerebral palsy: Targets for rehabilitation care. Arch. Phys. Med. Rehabil. 2009, 90, 1891–1897. [CrossRef]

8. Weber, P.; Bolli, P.; Heimgartner, N.; Merlo, P.; Zehnder, T.; Kätterer, C. Behavioral and emotional problems in children and adults with cerebral palsy. Eur. J. Paediatr. Neurol. 2016, 20, 270–274. [CrossRef]

9. Björquist, E.; Nordmark, E.; Hallström, I. Parents' experiences of health and needs when supporting their adolescents with cerebral palsy during transition to adulthood. Phys. Occup. Ther. Pediatr. 2016, 36, 204–216. [CrossRef]

10. Freeman, M.; Stewart, D.; Cunningham, C.E.; Gorter, J.W. Information needs of young people with cerebral palsy and their families during the transition to adulthood: A scoping review. J. Transit. Med. 2018, 1, 20180003. [CrossRef]

11. Qadeer, R.A.; Shanahan, L.; Ferro, M.A. Chronic disruptive pain in emerging adults with and without chronic health conditions and the moderating role of psychiatric disorders: Evidence from a population-based cross-sectional survey in Canada. Scand. J. Pain 2017, 17, 30–36. [CrossRef] [PubMed]

12. Ferro, M.A. Mediated moderation of the relation between maternal and adolescent depressive symptoms: Role of adolescent physical health. Soc. Psychiatry Psychiatr. Epidemiol. 2015, 50, 1743–1751. [CrossRef] [PubMed]

13. Ferro, M.A.; Gorter, J.W.; Boyle, M.H. Trajectories of depressive symptoms during the transition to young adulthood: The role of chronic illness. J. Affect. Disord. 2015, 174, 594–601. [CrossRef] [PubMed]

14. Kingsnorth, S.; Orava, T.; Provvidenza, C.; Adler, E.; Ami, N.; Gresley-Jones, T.; Mankad, D.; Slonim, N.; Fay, L.; Joachimides, N. Chronic pain assessment tools for cerebral palsy: A systematic review. Pediatr. Neurosurg 2015, 136, e947–e960. [CrossRef]

15. Van Der Slot, W.M.; Nieuwenhuijsen, C.; Van Den Berg-Emmons, R.J.; Bergen, M.P.; Hilberink, S.R.; Stam, H.J.; Roebroeck, M.E. Chronic pain, fatigue, and depressive symptoms in adults with spastic bilateral cerebral palsy. Dev. Med. Child Neurol. 2012, 54, 836–842. [CrossRef]

16. McMahon, J.; Harvey, A.; Reid, S.M.; May, T.; Antolovich, G. Anxiety in children and adolescents with cerebral palsy. J. Paediatr. Child Health 2020, 56, 1194–1200. [CrossRef] [PubMed]

17. Whitney, D.G.; Warschausky, S.A.; Ng, S.; Hurvitz, E.A.; Kamdar, N.S.; Peterson, M.D. Prevalence of Mental Health Disorders Among Adults With Cerebral Palsy: A Cross-sectional Analysis. Ann. Intern. Med. 2019, 171, 328–333. [CrossRef]

18. Smith, K.J.; Peterson, M.D.; O’Connell, N.E.; Victor, C.; Liverani, S.; Anokye, N.; Ryan, J.M. Risk of Depression and Anxiety in Adults With Cerebral Palsy. JAMA Neurol. 2016, 73, 294–300. [CrossRef]

19. Rackauskaite, G.; Blumenberg, N.; Uldall, P.; Bech, B.H.; Ostergaard, J. Prevalence of mental disorders in children and adolescents with cerebral palsy: Danish nationwide follow-up study. Eur. J. Paediatr. Neurol. 2020, 27, 98–103. [CrossRef]

20. Rayner, L.; Hotopf, M.; Petkova, H.; Matcham, F.; Simpson, A.; McCracken, L.M. Depression in patients with chronic pain attending a specialised pain treatment centre: Prevalence and impact on health care costs. Pain 2016, 157, 1472. [CrossRef]

21. Young, N.L.; McCormick, A.M.; Gilbert, T.; Ayling-Campos, A.; Burke, T.; Fehlings, D.; Wedge, J. Reasons for hospital admissions among youth and young adults with cerebral palsy. Arch. Phys. Med. Rehabil. 2011, 92, 46–50. [CrossRef] [PubMed]

22. Helseth, S.; Abebe, D.S.; Andenas, R. Mental health problems among individuals with persistent health challenges from adolescence to young adulthood: A population-based longitudinal study in Norway. BMC Public Health 2016, 16, 983. [CrossRef] [PubMed]

23. Bjorgaas, H.M.; Elgen, I.B.; Hysing, M. Trajectories of psychiatric disorders in a cohort of children with cerebral palsy across four years. Disabil. Health J. 2021, 14, 100992. [CrossRef] [PubMed]
24. Downs, J.; Blackmore, A.M.; Epstein, A.; Skoss, R.; Langdon, K.; Jacoby, P.; Whitehouse, A.J.; Leonard, H.; Rowe, P.W.; Glasson, E.J. The prevalence of mental health disorders and symptoms in children and adolescents with cerebral palsy: A systematic review and meta-analysis. Dev. Med. Child Neurol. 2018, 60, 30–38. [CrossRef] [PubMed]

25. Craig, F.; Savino, R.; Trabacca, A. A systematic review of comorbidity between cerebral palsy, autism spectrum disorders and Attention Deficit Hyperactivity Disorder. Eur. J. Pediatr. Neurol. 2019, 23, 31–42. [CrossRef]

26. Odding, E.; Roebroeck, M.E.; Stam, H.J. The epidemiology of cerebral palsy: Incidence, impairments and risk factors. Disabil. Rehabil. 2006, 28, 183–191. [CrossRef]

27. Pauli-Pott, U.; Schloß, S.; Ruhl, I.; Skoluda, N.; Nater, U.M.; Becker, K. Hair cortisol concentration in preschoolers with attention-deficit/hyperactivity symptoms—Roles of gender and family adversity. Psychoneuroendocrinology 2017, 86, 25–33. [CrossRef]

28. Chen, X.; Gelaye, B.; Velez, J.C.; Barbosa, C.; Pepper, M.; Andrade, A.; Gao, W.; Kirschbaum, C.; Williams, M.A. Caregivers’ hair cortisol: A possible biomarker of chronic stress is associated with obesity measures among children with disabilities. BMC Pediatr. 2015, 15, 9. [CrossRef]

29. Vives, A.H.; De Angel, V.; Papadopoulos, A.; Barbosa, C.; Pepper, M.; Andrade, A.; Gao, W.; Kirschbaum, C.; Williams, M.A. The relationship between cortisol, stress and psychiatric illness: New insights using hair analysis. J. Psychiatr. Res. 2015, 70, 38–49. [CrossRef]

30. Wells, S.; Tremblay, P.F.; Flynn, A.; Russell, E.; Kennedy, J.; Rehm, J.; Van Uum, S.; Koren, G.; Graham, K. Associations of hair cortisol concentration with self-reported measures of stress and mental health-related factors in a pooled database of diverse community samples. Stress 2014, 17, 334–342. [CrossRef]

31. Pochigaeva, K.; Druzhkova, T.; Yakovlev, A.; Onufriev, M.; Grishkina, M.; Chepelev, A.; Guekht, A.; Gulyaeva, N. Hair cortisol as a marker of hypothalamic-pituitary-adrenal Axis activity in female patients with major depressive disorder. Metab. Brain Dis. 2017, 32, 577–583. [CrossRef]

32. Abell, J.G.; Stalder, T.; Ferrie, J.E.; Shipley, M.J.; Kirschbaum, C.; Kivimäki, M.; Kumari, M. Assessing cortisol from hair samples in a large observational cohort: The Whitehall II study. Psychoneuroendocrinology 2016, 73, 148–156. [CrossRef] [PubMed]

33. Stalder, T.; Steudte-Schmiedgen, S.; Alexander, N.; Klucken, T.; Vater, A.; Wichmann, S.; Kirschbaum, C.; Miller, R. Stress-related and basic determinants of hair cortisol in humans: A meta-analysis. Psychoneuroendocrinology 2017, 77, 261–274. [CrossRef] [PubMed]

34. Kornelsen, E.; Buchan, M.C.; Gonzalez, A.; Ferro, M.A. Hair cortisol concentration and mental disorder in children with chronic physical illness. Chronic Stress 2019, 3, 2470547019875116. [CrossRef] [PubMed]

35. Posner, K.; Brown, G.K.; Stanley, B.; Brent, D.A.; Yershova, K.V.; Oquendo, M.A.; Currier, G.W.; Melvin, G.A.; Greenhill, L.; Shen, S. The Columbia–Suicide Severity Rating Scale: Initial validity and internal consistency findings from three multisite studies with adolescents and adults. Am. J. Psychiatry 2011, 168, 1266–1277. [CrossRef] [PubMed]

36. Spielberger, C.D. Manual for the State-Trait Anxiety Inventory; Consulting Psychologists Press: Palo Alto, CA, USA, 1983.

37. Julian, L.J. Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). Arthritis Care Res. 2011, 63, S467–S472. [CrossRef] [PubMed]

38. Bennett, D.A. How can I deal with missing data in my study? Aust. N. Z. J. Public Health 2001, 25, 464–469. [CrossRef] [PubMed]

39. Radloff, L.S. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. Appl. Psychol. Meas. 1977, 1, 385–401. [CrossRef]

40. Miller, W.; Anton, H.; Townson, A. Measurement properties of the CESD scale among individuals with spinal cord injury. Spin. Cord. 2008, 46, 287–292. [CrossRef]

41. Ferro, M.A.; Gorton, J.W.; Boyle, M.H. Trajectories of depressive symptoms in Canadian emerging adults. Am. J. Public Health 2015, 105, 2322–2327. [CrossRef]

42. Ryan, C.E.; Epstein, N.B.; Keitner, G.I.; Bishop, D.S.; Miller, I.W. Evaluating and Treating Families: The McMaster Approach; Taylor & Francis: Oxfordshire, UK, 2005.

43. Byles, J.; Byrne, C.; Boyle, M.H.; Offord, D.R. Ontario Child Health Study: Reliability and validity of the general functioning subscale of the McMaster Family Assessment Device. Fam. Process. 1988, 27, 97–104. [CrossRef] [PubMed]

44. Brunton, L.K.; Bartlett, D.J. Construction and validation of the fatigue impact and severity self-assessment for youth and young adults with cerebral palsy. Dev. Neurorehabil. 2017, 20, 274–279. [CrossRef] [PubMed]

45. Bartlett, D.J.; Hanna, S.E.; Avery, L.; Stevenson, R.D.; Galuppi, B. Correlates of decline in gross motor capacity in adolescents with cerebral palsy in Gross Motor Function Classification System levels III to V: An exploratory study. Dev. Med. Child Neurol. 2010, 52, e155–e160. [CrossRef] [PubMed]

46. Palisano, R.J.; Rosenbaum, P.; Bartlett, D.; Livingston, M.H. Content validity of the expanded and revised Gross Motor Function Classification System. Dev. Med. Child Neurol. 2008, 50, 744–750. [CrossRef]

47. Stalder, T.; Steudte, S.; Miller, R.; Skoluda, N.; Dettenborn, L.; Kirschbaum, C. Intraindividual stability of hair cortisol concentrations. Psychoneuroendocrinology 2012, 37, 602–610. [CrossRef]

48. Zhang, Q.; Chen, Z.; Chen, S.; Yu, T.; Wang, J.; Wang, W.; Deng, H. Correlations of hair level with salivary level in cortisol and cortisone. Life Sci. 2018, 193, 57–63. [CrossRef]

49. Kirschbaum, C.; Tietze, A.; Skoluda, N.; Dettenborn, L. Hair as a retrospective calendar of cortisol production-Increased cortisol incorporation into hair in the third trimester of pregnancy. Psychoneuroendocrinology 2009, 34, 32–37. [CrossRef]
50. Thomson, S.; Koren, G.; Fraser, L.-A.; Rieder, M.; Friedman, T.; Van Uum, S. Hair analysis provides a historical record of cortisol levels in Cushings’s syndrome. Exp. Clin. Endocrinol. Diabetes 2009, 118, 133–138. [CrossRef]
51. Wosu, A.C.; Valdimarsdóttir, U.; Shields, A.E.; Williams, D.R.; Williams, M.A. Correlates of cortisol in human hair: Implications for epidemiologic studies on health effects of chronic stress. Ann. Epidemiol. 2013, 23, 797–811.e2. [CrossRef]
52. Carifio, J.; Perla, R. Ten Common Misunderstandings, Misconceptions, Persistent Myths and Urban Legends about Likert Scales and Likert Response Formats and their Antidotes. J. Soc. Sci. 2007, 3, 106–116. [CrossRef]
53. Lakens, D. Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. Front. Psychol. 2013, 4, 863. [CrossRef] [PubMed]
54. Hanes, J.E.; Hlyva, O.; Rosenbaum, P.; Freeman, M.; Nguyen, T.; Palisano, R.J.; Gorter, J.W. Beyond stereotypes of cerebral palsy: Exploring the lived experiences of young Canadians. Child Care Health Dev. 2019, 45, 613–622. [CrossRef] [PubMed]
55. Smith, S.E.; Gannotti, M.; Hurvitz, E.A.; Jensen, F.E.; Krach, L.E.; Krueer, M.C.; Msall, M.E.; Noritz, G.; Rajan, D.S.; Aravamuthan, B.R. Adults with cerebral palsy require ongoing neurologic care: A systematic review. Ann. Neurol. 2021, 89, 860–871. [CrossRef] [PubMed]
56. Lundh, S.; Nasic, S.; Riad, J. Fatigue, quality of life and walking ability in adults with cerebral palsy. Disabil. Rehabil. 2020, 42, 43–48. [CrossRef] [PubMed]
57. van der Slot, W.M.A.; Benner, J.L.; Brunton, L.; Engel, J.M.; Gallien, P.; Hilberink, S.R.; Månum, G.; Morgan, P.; Opheim, A.; Riquelme, I.; et al. Pain in adults with cerebral palsy: A systematic review and meta-analysis of individual participant data. Ann. Phys. Rehabil. Med. 2021, 64, 101359. [CrossRef]
58. McKinnon, C.T.; Meehan, E.M.; Harvey, A.R.; Antolovich, G.C.; Morgan, P.E. Prevalence and characteristics of pain in children and young adults with cerebral palsy: A systematic review. Dev. Med. Child Neurol. 2019, 61, 305–314. [CrossRef]
59. van Gorp, M.; Hilberink, S.R.; Noten, S.; Benner, J.L.; Stam, H.J.; van der Slot, W.M.; Roebroeck, M.E. Epidemiology of Cerebral Palsy in Adulthood: A Systematic Review and Meta-analysis of the Most Frequently Studied Outcomes. Arch. Phys. Med. Rehabil. 2020, 101, 1041–1052. [CrossRef]
60. Whitney, D.G.; Bell, S.; Whibley, D.; Van der Slot, W.M.; Hurvitz, E.A.; Haapala, H.J.; Peterson, M.D.; Warschausky, S.A. Effect of pain on mood affective disorders in adults with cerebral palsy. Dev. Med. Child Neurol. 2020, 62, 926–932. [CrossRef]
61. Whitney, D.G.; Warschausky, S.A.; Whibley, D.; Kratz, A.; Murphy, S.L.; Hurvitz, E.A.; Peterson, M.D. Clinical factors associated with mood affective disorders among adults with cerebral palsy. Neurol. Clin. Pract. 2020, 10, 206–213. [CrossRef]
62. Brunton, L.K.; McPhee, P.G.; Gorter, J.W. Self-reported factors contributing to fatigue and its management in adolescents and adults with cerebral palsy. Disabil. Rehabil. 2021, 43, 929–935. [CrossRef]
63. McDougall, J.; DeWit, D.J.; Wright, F.V. Social anxiety symptoms among youth with chronic health conditions: Trajectories and related factors. Disabil. Rehabil. 2020, 42, 3293–3305. [CrossRef] [PubMed]
64. Asano, D.; Takeda, M.; Nobusako, S.; Morioka, S. Self-Rated Depressive Symptoms in Children and Youth with and without Cerebral Palsy: A Pilot Study. Behav. Sci. 2020, 10, 167. [CrossRef] [PubMed]
65. Bjorgaas, H.M.; Elgen, I.; Boe, T.; Rosenbaum, P.; Hlyva, O.; Freeman, M.; Nguyen, T.; Gorter, J. Mental health in children with cerebral palsy: Does screening capture the complexity? Sci. World J. 2013, 2013, 468402-02. [CrossRef]
66. Palisano, R.; Rezze, B.D.; Stewart, D.; Rosenbaum, P.; Hlyva, O.; Freeman, M.; Nguyen, T.; Gorter, J. Life course health development of individuals with neurodevelopmental conditions. Dev. Med. Child Neurol. 2017, 59, 470–476. [CrossRef] [PubMed]
67. Gorter, J.W. Transition to Adult-Oriented Health Care: Perspectives of Youth and Adults with Complex Physical Disabilities. Phys. Occup. Ther. Pediatr. 2009, 29, 362–366. [CrossRef]
68. Heye, H.; Jahnsen, R.B.; Løvstad, M.; Hartveit, I.F.; Serl, H.; Tornås, S.; Månun, G. A Mindfulness-Based Stress Reduction Program via Group Video Conferencing for Adults With Cerebral Palsy—A Pilot Study. Front. Neurol. 2020, 11, 195. [CrossRef] [PubMed]
69. Schwartz, A.E.; Young Adult Mental Health/Peer Mentoring Research Team; Kramer, J.M.; Rogers, E.S.; McDonald, K.E.; Cohn, E.S. Stakeholder-driven approach to developing a peer-mentoring intervention for young adults with intellectual/developmental disabilities and co-occurring mental health conditions. J. Appl. Res. Intellect. Disabil. 2020, 33, 992–1004. [CrossRef]