Master of Public Health

Master de Santé Publique

Association Between Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) with Mental Health and Quality of Life in 10-Year-Old Children

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Abstract in English

Association Between Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) with Mental Health and Quality of Life in 10-Year-Old Children

Objectives: To explore the impact of having a neurodevelopment Disorder (NDD) on emotional problems and quality of life (QoL) in 10.5-year-old children living in France and to examine whether lifestyle behaviors mediate or moderate these associations.

Methods: Among 9806 adolescents participating in the 10-year data wave of the ELFE cohort, 336 (3.4%) were clinically diagnosed by NDD and matched with 672 controls. Lifestyle behaviors including physical activity, sedentary behavior and dietary habits were collected. Associations with emotional problems (Strengths and Difficulties questionnaire) and QoL (Vécu et Santé Perçu de l'Adolescent) were analyzed using regression models adjusted for parental socioeconomic status, social network and support, and health indicators. Moderation analyses explored whether associations between lifestyle behaviors and outcomes varied by NDD status and mediation analyses tested whether lifestyle behaviors indirectly influenced emotional problems and QoL.

Results: Children with NDD had significantly higher odds of emotional problems (OR = 2.68; 95% CI: 2.00–3.59; $p < 0.001$) and lower QoL (β = –2.09; 95% CI: –3.6, –0.52; $p < 0.001$) than typically developed children (TDC). TDC were more likely to engage in active commuting and had higher total weekly physical activity ($p < 0.05$). Skipping at least one main meal (OR = 1.71; 95% CI: 1.02–2.86) and skipping breakfast (OR = 1.88; 95% CI: 1.08, 3.26) were associated with more emotional problems ($p < 0.05$). Eating with distraction was linked to lower QoL (β = -2.01; 95% CI: -3.97, -0.06). No significant moderation nor mediation effects were found ($p > 0.05$).

Conclusion: Children with NDD have more emotional problems and lower QoL were higher when compared to TDC. However, lifestyle behaviors didn't moderate nor mediate this relation. Future studies are needed to further understand this relation and identify other mechanisms that may contribute to emotional problems and lower QoL in children with NDD.

KEYWORDS: Neurodevelopmental Disorders (NDD), Emotional Problems, Quality of Life (QoL), Lifestyle behaviors.

Abstract in French

Association entre les troubles du spectre de l'autisme (TSA) et le trouble du déficit de l'attention avec ou sans hyperactivité (TDAH) avec la santé mentale et la qualité de vie chez les enfants âgés de 10 ans

Objectifs : Cette étude visait à explorer l'impact des troubles du neurodéveloppement (TDN) sur les problèmes émotionnels et la qualité de vie (QdV) des enfants âgés 10,5 ans en France, et à examiner si certains comportements liés au mode de vie médiaient ou modéraient ces associations.

Méthode : Parmi les 9806 enfants participant à la vague des 10 ans de la cohorte ELFE, 336 enfants (3,4%) TDN, 672 enfants neurotypiques (TDC) ont été inclus. Les comportements liés au mode de vie (activité physique, comportement sédentaire et habitudes alimentaires) ont été recueillis. Les associations avec les problèmes émotionnels (questionnaire Strengths and Difficulties) et la qualité de vie (Vécu et Santé Perçue de l'Adolescent) ont été étudiées par régressions ajustées sur le statut socioéconomique parental, le réseau social, le soutien, et des indicateurs de santé. Des analyses de modération et de médiation ont testé si les comportements liés au mode de vie modéraient ou médiait les problèmes émotionnels et la QdV.

Résultats : Les enfants TDN avaient plus de risques de présenter des problèmes émotionnels (OR = 2,68 ; IC 95 % : 2,00–3,59 ; $p < 0,001$) et des scores de QdV significativement plus faibles que les TDC ($\beta = –2,09$; IC 95 % : –3,6 à –0,52 ; $p < 0,001$). Les TDC empruntaient plus souvent un mode actif de déplacement et avaient un niveau d'activité physique hebdomadaire total plus élevé ($p < 0,05$). Le fait de sauter le petit-déjeuner (OR = 1,88 ; IC 95 % : 1,08–3,26) et au moins un repas principal (OR = 1,71 ; IC 95 % : 1,02–2,86) étaient associés à davantage de problèmes émotionnels ($p < 0,05$). Manger avec distraction était associé à une QdV plus faible ($\beta = –2,01$; IC 95 % : –3,97 à –0,06). Aucun effet significatif de médiation ni de modération n'a été observé ($p > 0,05$).

Conclusion : Les résultats indiquent que les enfants TDN présentent davantage de problèmes émotionnels et une QdV plus faible comparé aux enfants TDC. Toutefois, les comportements liés au mode de vie n'ont ni modéré ni médiatisé cette relation. Des études complémentaires sont nécessaires pour mieux comprendre ces associations et identifier d'autres mécanismes pouvant contribuer aux difficultés émotionnelles et à la QdV des enfants TDN.

Mots-clés : Troubles du neurodéveloppement (TND), Problèmes émotionnels, Qualité de vie (QdV), Facteurs liés au mode de vie.

Introduction

Autism spectrum disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) are neurodevelopmental disorders occurring early in life (Cervin, 2023; Sinzig et al., 2009). This population usually encounters challenges in diagnosis and in having access to appropriate support and treatments for their condition-related difficulties (French et al., 2023). Individuals with ASD exhibit deficits in social communication, repetitive behaviors, and presence of limited interest (Al Ghamdi & AlMusailhi, 2024; Hodges et al., 2020), whereas those with ADHD have their functional ability affected and suffer from developmental inappropriate levels of inattention, hyperactivity, and/or impulsivity (Magnus et al., 2025). Worldwide, approximately 1% are diagnosed with ASD and 5% with ADHD worldwide (Drechsler et al., 2020; Zeidan et al., 2022). Neurodevelopmental disorders (NDDs) - particularly autism spectrum disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) – have showed higher vulnerability to mental health problems (Chen et al., 2015; Garas & Balazs, 2020; Stadnick et al., 2022; Thapar et al., 2023). Growing attention toward mental health problems increased due to their psychological and social consequences (Boulton et al., 2023). Research showed that mental health issues cause disruptive behavior, decrease academic performance, and impair emotional relationships (Lin & Guo, 2024). These issues are more prevalent in individuals with neurodevelopmental disorders (Capp et al., 2023; Chen et al., 2015; Garrido et al., 2025) compared to typically developing individuals (McKinney et al., 2024). Moreover, children with ASD and ADHD showed to have lower quality of life (QoL) which may intensify with age (Lai et al., 2019; Sáez-Suanes & Álvarez-Couto, 2022; Tedla et al., 2024a; Thorell et al., 2019). Quality of life captures the well-being of an individual (Teoli & Bhardwaj, 2025) and studies have shown that better QoL was associated with lower risk of mortality (Phyo et al., 2020).

While mental health is shaped by different psychosocial factors such as strong community relationships, sense of autonomy or physical and emotional neglect (Cherewick et al., 2023), increasing attention has been given to the role of lifestyle behaviors (Zaman et al., 2019) such as physical activity (Biddle et al., 2019), sedentary behavior (Balasundaram & Krishna, 2025) and dietary patterns (Muscaritoli, 2021; O'Neil et al., 2014a). Regular exercise plays a crucial role in preventing and treating health-related conditions that impact public health (Schuch & Vancampfort, 2021). Studies showed that exercise impacts depression and anxiety as well it improves the function of hypothalamus-pituitary-adrenal axis, sleep and different psychiatric disorders too (Mahindru et al., 2023a). Also, physical activity promotes endorphins secretion that regulates mental health, relieves pain and increases the feeling of happiness and achievement leaving the individual with a positive impact (X.-Q. Liu & Wang, 2024). On the other hand,

sedentary behavior was associated with poor mood and negative influence on sleep and stress. It is considered as a risk factor which is associated with anxiety and depression (Barbosa et al., 2024). Many researches showed that the decrease in daily sedentary behavior improves mental health status, where a reduction by 1 hour/day can benefit the mood, stress and sleep (Ellingson et al., 2018). Finally, dietary habits such as regular breakfast consumption (O'Sullivan et al., 2009; Zhang et al., 2024) eating all main meals (breakfast, lunch and dinner) (Anderson, 2020; Pengpid et al., 2025a; Ptacek et al., 2014), choosing organic foods (Ismael & Ploeger, 2020) and mindful eating (Ersöz Alan et al., 2022) were also associated with reduced mental health problems. Children with autism spectrum disorder face major challenges, and often have problems in engaging in physical activity (Must et al., 2015). Similarly, children with ADHD generally get engaged in less physical activity (PA) than recommended (Mercurio et al., 2021). Additionally, lower levels of physical activity are associated with higher rates of sedentary behavior in children with neurodevelopmental disorders (NDD) compared to typically developing children (TDC) (H. Liu et al., 2024; Must et al., 2014; Suchert et al., 2017; Wu et al., 2022). Furthermore, children with ASD often experience food selectivity (Harris, Bowling, Santos, Greaves-Lord, et al., 2022) and those with ADHD are more impulsive and have tendency to hyperphagia (Harris, Bowling, Santos, Greaves-Lord, et al., 2022), which complicates the adoption of healthy lifestyle.

Lifestyle behaviors play also a vital role in improving quality of life especially by addressing unhealthy patterns such as physical inactivity and poor diet (Amiri et al., 2024) where the unhealthy lifestyle can lower QoL scores (FARHUD, 2015; Nari et al., 2021). Exercise has been positively associated with a better mood and improved quality of life (Jeng et al., 2025; Marquez et al., 2020). On the other hand, studies revealed that individuals who were physically inactive was associated with higher rates of morbidity (Mahindru et al., 2023b). Moreover, the excessive screen hours and adopting a sedentary lifestyle have shown to worsen quality of life and cause as well conduct problems (Xiang et al., 2022). Also, the dietary practices seemed to be associated with quality of life (Aljohani & Al-Zalabani, 2021). The unhealthy dietary habits showed to impair the cognitive function, increase risk of dementia and reduce quality of sleep (Cabral et al., 2025). Children with ASD are more prone to experience lower QoL compared to TDC (Tedla et al., 2024b). They are less likely to get engaged in physical activity and sedentary lifestyle (Folostina et al., 2023) and are more likely to exhibit atypical eating behaviors and follow different dietary habits (Weir et al., 2021). Similarly, children with ADHD may suffer from reduced QoL (Wanni Arachchige Dona et al., 2023) where they are also less likely to get engaged in healthy lifestyle (Holton & Nigg, 2020).

Several studies have examined the impact of neurodevelopmental disorders – particularly ASD and ADHD- on adolescent mental health and quality of life (QoL) (Heslon et al., 2024; Mahjoob et al., 2024; Schei et al., 2015; Skaletski et al., 2021). These studies consistently showed that adolescents with NDDs experience lower QoL where the presence of other co-occurring symptoms such as anxiety and depression would impact negatively mental health status. And this is of concern especially that adolescence is a critical period for mental development. Indeed, a meta-analysis of 192 epidemiological studies showed that in more than a third of individuals (34.6%), the first mental disorder appeared before the age of 14, and that the peak onset of disorders was at 14.5 years (Solmi et al., 2022). Mental health in adolescents is associated -among others- with parental educational level (Li et al., 2024; Torvik et al., 2020a), parental mental health (Ueda et al., 2022), and parenting involvement (Rasalingam & Rajalingam, 2021). However, only a small number of these studies have investigated the lifestyle behaviors —such as physical activity, sedentary behavior, and dietary habits—on mental health and QoL, despite strong evidence in general populations that these behaviors are crucial determinants of youth well-being (Biddle et al., 2019; Zaman et al., 2019).

The present study aims to explore the impact of having a neurodevelopmental disorder on emotional problems and quality of life in early adolescence, and whether any associations between neurodevelopmental status and emotional problems or QoL is moderated or mediated by lifestyle behaviors, such as physical activity, sedentary behavior and dietary habits.

We hypothesized that adolescents with neurodevelopmental disorder (ASD or ADHD) will report higher emotional problems and lower QoL compared to typically developing children (TDC). Furthermore, we suggested that healthier lifestyle behaviors characterized by higher levels of physical activity, lower sedentary behavior and good dietary habits will buffer the impact between NDD and adolescents' emotional problems and QoL.

This research is integrated within the larger eProSchools project which is co-financed by ANR and the European Union and involves collaboration between researchers from seven countries.

Method

The ELFE cohort study

This study used data from the French national longitudinal cohort *Etude Longitudinale Française depuis l'Enfance* (ELFE). The study recruited 18,329 children born in France in 2011 using random sampling from 320 maternity wards. Inclusion criteria included single or twin live babies at ≥33 weeks' gestation, mothers aged ≥18, no plans to leave metropolitan France within 3 years,

and signed parental or maternal agreement. The father was advised of his right to decline. The consent materials were provided in French, Arabic, Turkish, and English (Charles et al., 2020). Data collection was conducted at 2, 3.5, 5.5-, and 10-years using computer-assisted telephone interviews (CATI), personal interviews (CAPI), and web-based questionnaires (CAWI) from both parents and children where applicable.

This study focused on data collected during the 10-year wave (N= 9806), in 2021. Ethical approvals were granted by the national advisory committee on research conduct, participants protection and statistical information (Comité Consultatif sur le Traitement des Informations pour la Recherche en Santé: CCTIRS; Commission National Informatique et Libertés: CNIL ; CPP: Comité de Protection des Personnes ; CNIS: Conseil National de l'Information Statistique).

Presence of NDD in adolescents

Neurodevelopmental disorders were identified from parent-reported data throughout the follow up period of 10 years which were reviewed and re-coded by the ELFE medical team. Parents were asked standardized questions about their child's behavioral issues, developmental milestones, and any official diagnoses from medical professionals were posed to the parents. For instance, questions about communication, social interaction, and attention issues were asked, along with whether the child had been diagnosed with autism spectrum disorder, attention-deficit/hyperactivity disorder, or learning disabilities. In order to guarantee a consistent and precise classification of NDDs within the cohort, the medical team then examined these responses in conjunction with any available medical documentation. The ELFE team created an indicator of any Neurodevelopmental problem or delay including Attention-Deficit/Hyperactivity Disorder, autism spectrum disorders, cognitive disorders, behavioral disorders, language disorders, motor disorders, and psychological or psychiatric disorders with 918 children being identified with NDD. We retained those children who were identified as having ASD, ADHD or neither. Children diagnosed with both ASD and ADHD were excluded from the analyses to reduce heterogeneity and isolate the specific associations for each condition. A 2:1 ratio random sampling of TDC was performed to maintain statistical efficiency and balance using R version 4.3.1, resulting in 672 TDC, 52 ASD, and 284 ADHD participants (Figure 1).

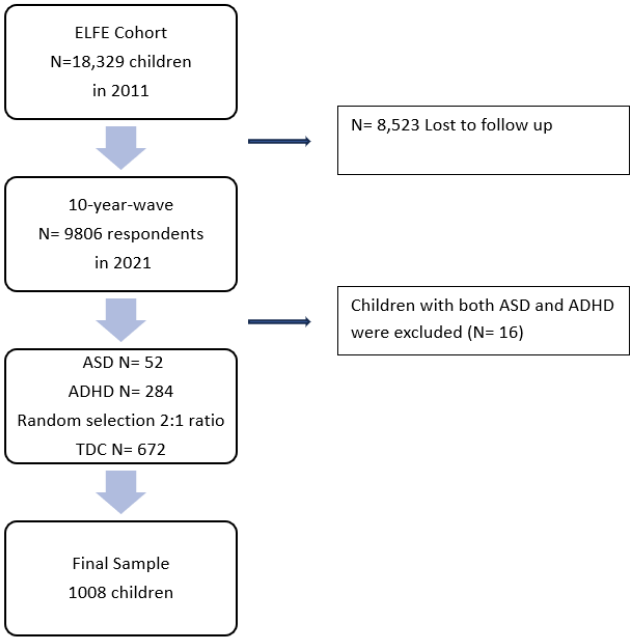


Figure 1 – Flowchart describing sample selection, ELFE cohort study 2011-2021

Measures

Mental Health

Child mental health was assessed using the *Strengths and Difficulties Questionnaire* (SDQ) which is a validated screening tool for emotional and behavioral problems (Goodman, 2001). It contains 25 questions tapping into 5 dimensions: emotional problems, conduct problems, hyperactivity/inattention, peer relationship problems, and total difficulties. To reduce redundancy and avoid reducing the specificity of our findings, we focused in this study, on emotional problems subscale since other dimensions are already embedded by concept and diagnosis within the core features of ASD and ADHD. The emotional problems score ranging from 0-10, is derived from 5 items assessing: *"complains of headache/stomach ache"; "Many worries, often seems worried"; "Often unhappy, down-hearted or tearful"; "Nervous or clingy in new situations, easily loses confidence"; and "Many fears, easily scared*"(Hall et al., 2019). The score was dichotomized based on validated cut-offs: scores of <5 for "normal" and 5–10 as "abnormal"(Bryant et al., 2020).

Quality of Life

Children's quality of life was measured using the short self-report version of the *Vécu et Santé Perçus de l'Enfant et de l'Adolescent* (VSP-A), a validated French questionnaire to capture the child's own perspective adapted to the age group of a child aged 10. This is the short version of 20 item-questionnaire which allows a quality-of-life score to be calculated in 6 dimensions (Relationships with the family; Self-esteem; Vitality & Physical and psychological well-being;

Friends Relations & Communication; Leisure; Schoolwork) and an overall index score. Scores range from 0 to 100, with a higher score indicating a better assessment of one's own quality of life (Sapin et al., 2005; Simeoni et al., 2000). In this study, we focused on global VSP-A index score that will allow us to get more insights on the overall evaluation derived from the 6 dimensions to provide a comprehensive understanding of general well-being: *"Have your parents reassured, encouraged, or helped you with school, your future, or your life in general?"*, *"Have other family members helped or encouraged you?"*, *"Have you been able to talk with your friends?"*, *"Have you been able to talk about your problems with your parents?",* and *"Have you been able to do sports or other activities that you enjoy?"*.

Lifestyle Behaviors

Physical Activity

The total physical activity was assessed and calculated by adding up the total active minutes of the week collected from active school commute, supervised activity, and unsupervised activity derived from parental responses. Each variable was calculated according to the following questions:

Active commuting: *"To go to school, what means of transport are most often used by the child?", "Each time how long does it usually take for a one-way trip in minutes?", "And to return from school, does the child use the same means of transport?*", and *"Each time how long does it usually take for a return trip in minutes?".* Transport modes were categorized as active (if the child walked or used a bicycle/scooter – i.e., "walking" or "bicycle/scooter (non-electric)") or inactive (if the child used a car, bus, train, tramway, or metro). The number of active commuting minutes was calculated by summing the duration of the one-way and return trips for each school day, multiplied by 5 (school days per week), only when the transport mode was active.

Unsupervised physical activity: whether the child engages in physical activity alone or with peers/siblings when weather permits *("Currently, weather permitting, does it happen that [Enfant ELFE] does sports alone or with friends, brothers or sisters, such as skateboarding, rollerblading or playing ball?"),* how frequently this occurs per week *("How many times a week?"),* and the average duration of each session *("On average, how much time does he/she spend there each time?").*

Supervised physical activity: whether the child participated in organized or instructor-led sports *("Did he/she participate in supervised sports activities?")* and the total time spent per week in these activities *("How much time per week? (Minutes)").* The questionnaire also provided examples of such sports to guide responses, including football, rugby, dance (classical, modern,

jazz, hip-hop, etc.), skateboarding, rollerblading, scooter, ice skating, field hockey, basketball, handball, volleyball, baseball, American football, skiing, fencing, martial arts (e.g., judo, karate, boxing), and racket sports (e.g., tennis).

Sedentary Behaviors

Sedentary behavior was assessed through the proxy of screentime and was evaluated based on duration of daily screen time exposure.

Dietary Habits

Dietary habits were assessed by consumption of organic food, main meals, breakfast and mindful eating. Organic food consumption was evaluated based on how often the child consumed organic fruits, vegetables, and cereals at home using a Likert-type scale (ranging from 1 to 4, 1 being always, 4 never). For analysis, responses were dichotomized *("When your child eats fruits or vegetables at home, are they organic?"), ("When your child eats cereals such as bread, pasta, rice, or flour at home, are they organic?").* Mindful eating was assessed based on screen use during dinner *("In general, during the evening meal, does your child watch or use a screen such as a TV, tablet, computer, video game, or smartphone?").* Main meals consumption (eating all the three main meals-breakfast, lunch and dinner) and breakfast consumption were defined based on the child's self-reported responses. Questions asked were: *("In general, do you eat breakfast?"), ("In general, do you eat lunch?"), ("In general, do you eat dinner?")*. These multiple lifestyle behaviors were included in the study to explore their impact on emotional problems and quality of life in children with NDD.

Covariates

Potential confounders of the association between neurodevelopmental disorders (NDD) and mental health and quality of life and lifestyle behaviors were chosen based on literature review and statistical selection included food allergies (yes; no), siblings (yes; no), at least one friend (yes; no), at least one best friend (yes; no). We also examined potential confounders related to family characteristics: monthly household income, education level (< baccalaureate vs ≥ baccalaureate), parents lived together (yes; no), financial difficulties over the child's first 10 years (yes; no), tobacco exposure (likert-type scale ranging from 1 to 5, 1 being never, 5 being exposed>5 hrs/day) which was dichotomized. Parental depressive symptoms were coded as "yes" if parents responded by "yes" to at least one of two questions regarding persistent sadness or loss of interest lasting at least two weeks in the past year. Additionally, parental engagement and supervision in daily activities (yes; no), (ALABAMA questionnaire) (Elgar et al., 2007; Shelton et al., 1996).

Statistical Analysis

To handle missing data, all analyses were performed on multiple imputed databases using the MICE package on R studio. Pearson correlation test was performed to explore the relationships between the different lifestyle variables. Descriptive statistics summarized the participant characteristics (counts and percentages for categorical variables; means ± SD for continuous variables). Group comparison between children with neurodevelopmental disorders (NDD) and typically developing children (TDC) on each lifestyle variable was performed using Pearson's Chi-square and t-tests.

For examining the association between NDD and emotional problems on one hand and with quality of life on the other hand, bivariate logistic regression and linear regression were performed, respectively. Similarly, separate multivariable logistic and linear regression models were conducted to test association between NDD and emotional problems and QoL and also to test association between each lifestyle variable (total of 9 regressions) and the outcomes and how it varies after adjusting for covariates. Covariates were selected based on literature and afterwards based on statistical significance (p-value). Emotional problem was adjusted by covariates*:* parents' depressive symptoms, child's food allergy, parents living together, financial problems. Whereas, quality of life was adjusted by parents living together, financial problems, best friend(s), friend(s), father's education.

Moderation analyses were conducted to examine whether the strength of direction of the association between neurodevelopmental disorders (NDD) and the outcomes varied across different levels of potential moderator variables (e.g. lifestyle behaviors). Moderation analyses tested interaction effects across levels of potential moderators. Interaction terms between NDD and each moderator were included in the regression models, and significant interaction effects were further explored using simple slopes analysis to interpret the nature of the moderation.

Mediation analysis was performed to test whether the association between neurodevelopmental disorders (NDD) and outcomes was explained, in part, through indirect pathways involving lifestyle behaviors. The analysis estimated both the direct effect of NDD on outcomes and the indirect effect transmitted via each lifestyle behavior, using bootstrapping techniques to test the significance of the mediated pathways.

ASD and ADHD groups were initially analyzed separately, but due to non-significant differences in emotional problems, they were combined as NDDs, results for both ASD and ADHD individually are presented as part of sensitivity analyses.

All analyses were performed using RStudio (v4.3.1) and relevant packages used are: mediation, tidyr, ggplot2, dplyr, mice, VIM, car, gtsummary, gt, summarytools, tableone, broom, Hmisc, interactions, sjPlot, corrplot, ggcorrplot, and ggeffects.

Results

Characteristics of Study Participants

Compared to typically developing children (TDC), children with neurodevelopmental disorders (NDD) showed several differences in family and environmental characteristics. While maternal education levels were similar between the two groups, parents of children with neurodevelopmental disorders (NDD) reported lower levels of paternal education ($p = 0.014$), and more financial difficulties during the first 10 years of their child's life ($p < 0.001$). Fewer children with neurodevelopmental disorders (NDD) lived with both parents ($p < 0.001$) compared to typically developing children (TDC) and parents of children with neurodevelopmental disorders (NDD) reported lower average monthly income ($p < 0.001$). Fewer children with NDD also had siblings ($p = 0.046$) compared to typically developing children (TDC). Regarding psychosocial factors, parental engagement scores were slightly but significantly lower in the NDD group than in the TDC group ($p = 0.006$). Parental depressive symptoms were more prevalent in the NDD group, compared to TDC group ($p < 0.001$). Children with neurodevelopmental disorders (NDD) were also more likely to have food allergies ($p = 0.03$) and to be exposed to tobacco smoke at home ($p = 0.001$).

In terms of emotional wellbeing, 81.7% of TDC were rated as normal versus only 58.0% in children with NDD ($p < 0.001$). Quality of life scores were also higher among TDC than the NDD group ($p < 0.001$). No significant differences in physical activity were seen for both supervised and unsupervised activity minutes. Nonetheless, the TDC group had a higher percentage of children who commuted actively and who engaged in more physical activity overall each week ($p < 0.05$). Children with neurodevelopmental disorders (NDD) had slightly more sedentary behavior than TDC, but the difference was not statistically significant ($p = 0.06$). None of the dietary habits such as eating organic food, breakfast, main meals, and mindful eating different between TDC and NDD. Further characteristics are presented in table 1.

Table 1: Sample Characteristics of TDC and NDD adolescents at the 10-year wave in the French ELFE cohort (n= 1008).

	Level	TDC (*N* = 672)	NDD (*N* = 336)	p.value
Parents' Socioeconomic				
Financial Problems *n* (%)	Yes	158 (23.5)	158 (47.0)	**<0.001**
	No	514 (76.5)	178 (53.0)	
Mother's Education *n* (%)	< baccalaureate	20 (3.0)	15 (4.5)	0.301
	≥ baccalaureate	652 (97.0)	321 (95.5)	
Father's Education *n* (%)	< baccalaureate	38 (5.7)	34 (10.1)	**0.014**
	≥ baccalaureate	634 (94.3)	302 (89.9)	
Parents Living together *n* (%)	Yes	541 (80.5)	229 (68.2)	**<0.001**
	No	131 (19.5)	107 (31.8)	
Revenue (monthly) M(SD)		1966.75 (1071.71)	1687.91 (999.15)	**<0.001**
Social Network/ Support				
Sibling(s) *n* (%)	Yes	616 (91.7)	294 (87.5)	**0.046**
	No	56 (8.3)	42 (12.5)	
Best Friend(s) *n* (%)	No	59 (8.8)	43 (12.8)	0.06
	Yes	613 (91.2)	293 (87.2)	
Friend(s) *n* (%)	Yes	669 (99.6)	331 (98.5)	0.167
	No	3 (0.4)	5 (1.5)	
Parental Supervision M(SD)		1.11 (0.23)	1.13 (0.26)	0.197
Parental Engagement M(SD)		3.93 (0.38)	3.85 (0.49)	**0.006**
Health Related Indicators				
Parents' Depressive Symptoms *n* (%)	No	520 (77.4)	199 (59.2)	**<0.001**
	Yes	152 (22.6)	137 (40.8)	
Child's Food Allergy *n* (%)	Yes	24 (3.6)	23 (6.8)	**0.03**
	No	648 (96.4)	313 (93.2)	
Tobacco Exposure *n* (%)	No	659 (98.1)	316 (94.0)	**0.001**
	Yes	13 (1.9)	20 (6.0)	
Child's Mental Health				
Emotional Problems *n* (%)	normal	549 (81.7)	195 (58.0)	**<0.001**
	abnormal	123 (18.3)	141 (42.0)	
Quality of Life M(SD)		67.89 (11.10)	65.11 (12.64)	**<0.001**
Physical Activity				
Active school commute M(SD)		42.41 (40.97)	35.16 (40.80)	**0.008**
Supervised weekly activities		7.95 (13.48)	7.89 (13.64)	0.942

M(SD)				
Unsupervised weekly activities M(SD)		6.12 (5.01)	6.48 (5.17)	0.283
Total PA min/week M(SD)		56.48 (43.17)	49.53 (43.57)	**0.016**
Sedentary Behavior				
Screen time M(SD)		2.33 (1.51)	2.52 (1.61)	0.06
Dietary Habits				
Organic food *n* (%)	no	379 (56.4)	209 (62.2)	0.09
	yes	293 (43.6)	127 (37.8)	
Main meals *n* (%)	All meals	628 (93.5)	305 (90.8)	0.161
	Missed ≥ 1 meal	44 (6.5)	31 (9.2)	
Breakfast *n* (%)	Yes	636 (94.6)	309 (92.0)	0.129
	No	36 (5.4)	27 (8.0)	
Mindful eating *n* (%)	Yes	569 (84.7)	280 (83.3)	0.647
	No	103 (15.3)	56 (16.7)	

Bold font for p. values represents statistically significant differences

Association between Neurodevelopmental Disorders and Emotional Problems and Quality of Life

Children with neurodevelopmental disorders (NDD) were more likely to have emotional problems compared to typically developed children (TDC) (OR= 3.23; 95% CI: 2.44–4.27) with a significant *p*-value. Even after adjusting for covariates, the association remained significant (OR = 2.68; 95% CI: 2.00–3.59).

Similarly, children with neurodevelopmental disorders (NDD) showed lower quality of life scores compared to typically developed children (TDC) (β coefficient= –2.78; 95% CI: –4.37, –1.19). The association remained statistically significant even after adjusting for covariates (β coefficient= –2.09; 95% CI: –3.6, –0.52).

Table 2: Association between neurodevelopmental disorders and emotional problems and quality of life

	Emotional Problems		Quality of Life	
	OR unadjusted	OR adjusted	β coefficient unadjusted	β coefficient adjusted*
NDD_TDC	**3.23 (2.44 – 4.27)**	**2.68 (2.00 – 3.59)**	**-2.78 (–4.37, –1.19)**	**-2.09 (–3.65, –0.52)**

Adjusted by covariates of emotional problems: Parents' Depressive Symptoms, Child's Food Allergy, Parents Living together, Financial Problems.

Adjusted by covariates of quality of life: Parents Living together, Financial Problems, Best Friend(s), Friend(s), Father's Education. *Bold font represents statistically significant differences.*

**based on 95% CI excluded the null and P ≤ 0.05*

Association of Lifestyle Behaviors with Emotional Problems and Quality of Life of Adolescents with NDD

Lifestyle behaviors were significantly correlated amongst themselves (Appendix 1). Among the physical activity indicators, only more unsupervised weekly active minutes were associated with a slightly lower risk of emotional problems for NDD in unadjusted models (OR = 0.97; 95% CI: 0.94-0.99), but this relationship was no longer statistically significant in adjusted models (adjusted OR = 0.97; 95% CI: 0.94-1.00) (table 3).

Sedentary behavior was not associated with higher risk of emotional problems in neither unadjusted or adjusted models.

For dietary habits, missing at least one main meal was linked to increased odds of emotional problems (adjusted OR = 1.71; 95% CI: 1.02-2.86), as was skipping breakfast was associated with significantly higher odds of emotional problems after controlling for potential confounders in children with NDD compared to TDC (adjusted OR = 1.88; 95% CI: 1.08–3.26). No additional lifestyle behaviors were significantly associated with emotional problems.

Table 3: Association of lifestyle behaviors with emotional problems of adolescents with NDD.

	Emotional Problems	
	OR unadjusted	**OR adjusted**
Physical activity		
Active School Commute	0.99 (0.99, 1.00)	1.00 (1.00, 1.00)
Supervised weekly activities	0.99 (0.98, 1.01)	1.00 (0.98, 1.01)
Unsupervised weekly activities	**0.97 (0.94, 0.99)**	0.97 (0.94, 1.00)
Total Active minutes/week	0.99 (0.99, 1.00)	1.00 (1.00, 1.00)
Sedentary behavior		
Screen Time	1.08 (0.98, 1.18)	1.05 (0.95, 1.15)
Dietary habits		
Main meals Missed ≥1 meal	**1.76 (1.05, 2.91)**	**1.71 (1.02, 2.86)**
Organic Food yes	0.85 (0.63, 1.15)	0.86 (0.64, 1.16)
Breakfast No	**1.94 (1.12, 3.33)**	**1.88 (1.08, 3.26)**
Mindful Eating Eating with distraction	1.25 (0.85, 1.83)	1.15 (0.78, 1.71)

Adjusted by covariates: Parents' Depressive Symptoms, Child's Food Allergy, Parents Living together, Financial Problems. Bold font represents statistically significant differences.
**based on 95% CI excluded the null and P ≤ 0.05.*

Concerning the associations between lifestyle behaviors and quality of life score differences between TDC and NDD, only eating with distraction, was linked to lower quality of life in both unadjusted and adjusted models, as measured by linear regression β coefficients (adjusted β = –2.01; 95% CI: –3.97 to –0.06) (Table 4).

Table 4: Association of lifestyle behaviors with quality of life of adolescents with NDD.

	Quality of Life	
	β coefficient unadjusted	**β coefficient adjusted***
Physical activity		
Active School Commute	0.01 (-0.01, 0.03)	0.01 (-0.01,0.02)
Supervised weekly activities	-0.01 (-0.07, 0.04)	-0.01 (-0.06,0.04)
Unsupervised weekly activities	-0.02 (-0.16, 0.13)	-0.04 (-0.18,0.10)
Total Active minutes/week	0.01 (-0.01, 0.02)	0.00 (-0.01,0.02)
Sedentary behavior		
Screen Time	-0.32 (-0.79, 0.15)	-0.27 (-0.75,0.20)
Dietary habits		
Main meals Missed ≥1 meal	0.54 (-2.22, 3.29)	0.72 (-2.01,3.44)
Organic Food yes	-0.20 (-1.67, 1.27)	-0.29 (-1.74,1.16)
Breakfast No	-0.77 (-3.76, 2.22)	0.96 (-1.99,3.93)
Mindful Eating Eating with distraction	**-2.01 (-3.99, –0.03)**	**-2.01 (-3.97, -0.06)**

Adjusted by covariates: Parents Living together, Financial Problems,* Best Friend(s), Friend(s), Father's Education.
Bold font represents statistically significant differences.
**based on 95% CI and P ≤ 0.05.*

Moderating Effects on the Association Between Lifestyle Behaviors, Emotional Problems, and Quality of Life in Adolescents with Neurodevelopmental Disorders (NDD)

Moderation analyses were performed to explore whether lifestyle behaviors moderate the association between TDC and NDD groups and emotional problems or quality of life. No significant interaction effects between the two groups and lifestyle behaviors on emotional problems and quality of life (Table 5). However, as both main meals and organic food were close to significance, predicted probability slopes were further probed in order to further investigate the influence of diet. Consuming organic food was linked to a 9% decrease in the predicted likelihood of emotional problems in the TDC group (from 29% to 20%). On the other hand, eating more organic food was linked to a 5% increase in the NDD group (from 45% to 50%) (Figure 2). Compared to those who ate all three main meals, the TDC group experienced a slight increase in emotional problems (by less than 5%) as a result of missing meals. On the other hand, missing at least one of the main meals raised the likelihood of emotional issues in children with NDD by about 25% (Figure 3).

Table 5: Moderation analyses models of lifestyle behaviors tested separately along with Emotional Problems and Quality of Life

	Emotional Problems			Quality of Life		
	Estimate	Std. Error	p-value	Estimate	Std. Error	p-value
Active School Commute	0.005	0.004	0.218	0.008	0.019	0.65
Supervised weekly activities	0.0119	0.011	0.297	0.069	0.057	0.221
Unsupervised weekly activities	0.033	0.032	0.316	-0.154	0.151	0.306
Total Active minutes/week	0.006	0.003	0.114	0.012	0.0178	0.496
Screen Time	-0.065	0.094	0.488	0.187	0.492	0.704
Main Meals	***0.973***	***0.563***	***0.084***	1.396	2.829	0.622
Organic Food	***0.611***	***0.313***	***0.051***	-1.921	1.58	0.224
Breakfast	-0.657	0.588	0.264	-2.126	3.054	0.486
Mindful Eating	-0.002	0.402	0.996	-0.329	2.085	0.875

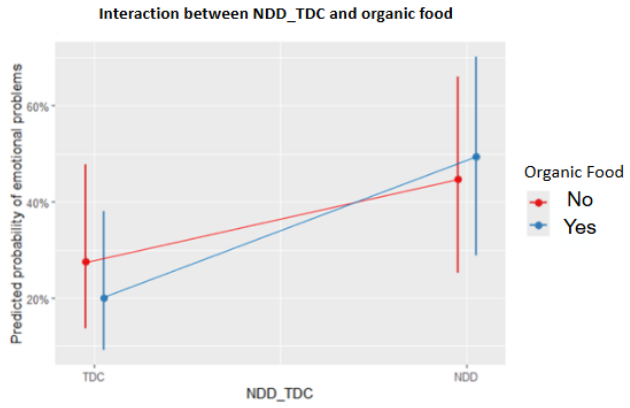


Figure 2: Interaction and slope visualization between NDD and Organic food with predicted probability of emotional problems.

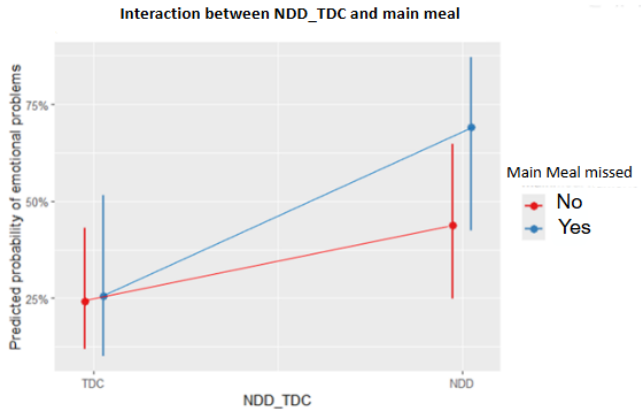


Figure 3: Interaction and slope visualization between NDD and main meal with predicted probability of emotional problems

Mediation Analyses of the Pathways Linking Lifestyle Behaviors, Emotional Problems, and Quality of Life in Adolescents with NDD

Potential indirect pathways were examined through counterfactual mediation models, with lifestyle behaviors tested as mediators of the relationship between emotional problems (Table 6.a) and quality of life (Table 6.b). None of the lifestyle behaviors showed any indirect effects ($p > 0.05$ across all models). However, across all tested models, the direct effect children with NDD on emotional problems and quality of life remained consistently significant.

Table 6.a.: Mediation models of lifestyle behaviors tested separately along with emotional problems.

Effect	Active School Commute	Supervised weekly activities	Unsupervised weekly activities	Total active min/week	Screentime	Breakfast	Main meal	Mindful eating	Organic food
Emotional Problems	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Average Causal Mediation Effect (control)	0	0	-0.002	0	-0.001	0.002	0.001	-0.001	0
Average Causal Mediation Effect (treated)	0	0	-0.003	0	-0.001	0.002	0.002	-0.001	0
Average Direct Effect (control)	**0.189**	**0.192**	**0.192**	**0.189**	**0.194**	**0.189**	**0.19**	**0.191**	**0.19**
Average Direct Effect (treated)	**0.189**	**0.192**	**0.191**	**0.19**	**0.193**	**0.189**	**0.19**	**0.191**	**0.191**
Total Effect	**0.188**	**0.192**	**0.189**	**0.19**	**0.193**	**0.191**	**0.191**	**0.19**	**0.191**
Proportion Mediated (control)	-0.001	0	-0.008	0	-0.002	0.006	0.005	-0.00099	0
Proportion Mediated (treated)	-0.001	0	-0.012	0	-0.004	0.008	0.007	-0.002	0
Average Causal Mediation Effect (average)	0	0	-0.002	0	-0.001	0.002	0.002	-0.001	0
Average Direct Effect (average)	**0.189**	**0.192**	**0.191**	**0.189**	**0.194**	**0.189**	**0.19**	**0.191**	**0.19**
Proportion Mediated (average)	-0.001	0	-0.01	0	-0.003	0.007	0.006	-0.001	0

Bold font for p. values represents statistically significant differences

Table 6.b.: Mediation models of lifestyle behaviors tested separately along with quality of life.

Effect	Active School Commute	Supervised weekly activities	Unsupervised weekly activities	Total active min/week	Screentime	Breakfast	Main meal	Mindful eating	Organic food
Quality of Life	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Average Causal Mediation Effect (control)	0	0	-0.002	0	-0.001	0.002	0.001	0	0
Average Causal Mediation Effect (treated)	0	0	-0.003	0.001	-0.001	0.002	0.002	-0.001	0
Average Direct Effect (control)	**0.191**	**0.192**	**0.192**	**0.192**	**0.192**	**0.189**	**0.189**	**0.191**	**0.191**
Average Direct Effect (treated)	**0.19**	**0.192**	**0.191**	**0.192**	**0.191**	**0.19**	**0.189**	**0.191**	**0.191**
Total Effect	**0.19**	**0.191**	**0.189**	**0.192**	**0.191**	**0.192**	**0.191**	**0.19**	**0.191**
Proportion Mediated (control)	0	0	-0.008	0.001	-0.002	0.006	0.005	-0.001	0.001
Proportion Mediated (treated)	-0.001	0	-0.012	0.001	-0.004	0.008	0.007	-0.001	0.001
Average Causal Mediation Effect (average)	0	0	-0.002	0	-0.001	0.002	0.002	-0.001	0
Average Direct Effect (average)	**0.191**	**0.192**	**0.192**	**0.192**	**0.191**	**0.189**	**0.189**	**0.191**	**0.191**
Proportion Mediated (average)	-0.001	0	-0.01	0.001	-0.003	0.007	0.006	-0.0011	0.001

Bold font for p. values represents statistically significant differences

Discussion

Key Results

This research explored the impact of neurodevelopmental disorders (NDD) on both emotional problems and QoL in 10.5-year-old children compared to typically developing children (TDC). Also, this study assessed role of lifestyle behaviors contributing to these associations, as well as their potential moderating or mediating role. The findings revealed that children with NDD showed significantly increased odds of having emotional problems and lower QoL scores compared to TDC. In addition to this, lower levels of physical activity, higher sedentary behavior, and less favorable dietary habits were more prevalent among children with NDD. Also, upon examining the

relationship of emotional problems and quality of life with the lifestyle behaviors in nine regression models to test the lifestyle variables separately, skipping breakfast and skipping any of the main meals showed to be associated with higher emotional problems whereas, eating with distraction showed association with lower quality-of-life scores. Finally, lifestyle behaviors did not moderate nor mediate the relationship between neurodevelopmental disorders and neither emotional problems nor quality of life.

As predicted, the regression analyses showed that the odds of having emotional problems were three times higher in children with neurodevelopmental disorders and this association remained significant even after adjusting for covariates. Similarly in examining the quality-of-life scores, results showed that children with NDD had lower scores compared to TDC in both unadjusted and adjusted models. These results suggested that the neurodevelopmental disorders were independent factor that was associated with an increase in emotional problems and decrease in quality-of-life scores. Our findings aligned with studies conducted in different other countries such as Spain, Japan and Finland (Löytömäki et al., 2023; Morales-Hidalgo et al., 2023; Shirama et al., 2022) that examined the association between children with NDD and emotional problems. In addition to previous studies such as the observational study conducted on 1578 children with ADHD living in 10 different European countries aged between 6 and 18 years old (Rocco et al., 2021) and another cross-sectional study conducted on 75 ASD children in Saudi Arabia (Tedla et al., 2024c) where symptoms of neurodevelopmental disorders contributed to a lower quality of life.

Although more unsupervised weekly active minutes were associated with a slightly lower risk of emotional problems in unadjusted models, this relationship was no longer statistically significant in adjusted models suggesting that other factors may have influenced this relation between NDD and emotional problems. Additionally, active school commute and supervised physical activity did not show any association in both unadjusted and adjusted models probably due to either lack of association or measurement limitation. Nevertheless, this lack of association aligned with findings of the Tromsø Study- a longitudinal study that reported no significant relationship between changes in the measured physical activity and changes in mental distress over two years among general adolescents population (Opdal et al., 2019). On the other hand, none of the physical activity variables-active school commute, supervised activity, and unsupervised activity- has shown any association with quality of life in both unadjusted and adjusted models which suggest that the intensity level of these physical activities has impacted the results. A study conducted across 10 schools among adolescents in Changsha, China with 426 students revealed the impact

of the exerted intensity of the physical activity when it ranges between moderate to vigorous. It showed a positive association with emotional intelligence and psychosocial stress (H. Wang et al., 2023).

Screen time showed no association with emotional problems in both unadjusted and adjusted models suggesting that maybe not all screentime is associated with negative impact on mental health especially on children with neurodevelopmental disorders (NDD). Several studies mentioned that screentime is not equally harmful and that the its impact differs whether it was spent using social media, internet gaming or TV (Twenge & Farley, 2021).

Moreover, the findings of this research also suggested that some of the dietary habits showed significant associations with emotional problems and QoL in children with neurodevelopmental disorders (NDD). Mainly, skipping breakfast and skipping any of the main three meals were associated with significantly higher odds of emotional problems after controlling for potential confounders in children with neurodevelopmental disorders (NDD) compared to typically developing children (TDC). This revealed that regular consumption of breakfast and the three main meals are important in the regulation of emotional problems. This finding was supported by several previous studies. A cross sectional study between December 2022 and May 2023 with Turkish adolescents from 17 high schools, representing the general population, showed that those who consumed breakfast had better mental health (Gürbüz et al., 2024). Moreover, a study conducted in the Philippines of 2019 Philippines Global School- based Student Health Survey showed that skipping any main meal induced mental health challenges in general school-going adolescents aged 11 to 18 (Pengpid et al., 2025b). This revealed the protective role that regular meal consumption plays on both emotional problems which could be explained by impact of good food habits on health (Caamaño-Navarrete et al., 2025). However, skipping breakfast and skipping any of the main meals did not show any association with quality of life and this aligned with a systematic review study done on 40 studies where it shed light on not only the importance of frequency of meals but also the crucial influence of the quality of the meals consumed which could further explain our results (López-Gil et al., 2024). Regarding mindful eating, our findings showed that it was not associated with emotional problems, however; was associated with a lower quality of life. Studies showed that eating with distraction could have many complications, among others obesity (de Lara Perez & Delgado-Rios, 2022), which was highly linked to mental QoL (Kokka et al., 2023).Also, in 2023, 13,759 participants from the NutriNet-Santé cohort, mindful eating was associated with a healthier diet (Paolassini-Guesnier et al., 2025) that is considered a main foundation in QoL due to the good supply of the energy needed for vital processes in the

human body such as growth, development and well-being (Itani et al., 2021). Finally, consumption of organic food revealed no association with neither emotional problems nor quality of life in both unadjusted and adjusted models suggesting the need to investigate the role of other food choices beyond organic food for their potential impact on the relation between NDD and emotional problems. Our findings aligned with a cross-sectional study that was conducted with young Norwegian adolescents using Food Frequency Questionnaire (FFQ) where it showed that the rich diet that contains wide variety such as unrefined plant foods, fish and regular meals was associated with better mental health (Oellingrath et al., 2014). Similarly in a study that included 1139 adolescents in Sweden where it showed that diet diversity and the inclusion of wide variety of food along with fruits and vegetables was positively associated with quality of life (Regan et al., 2022).

Moderation analyses revealed no significant interaction effects between lifestyle behaviors and TDC or NDD groups on emotional problems and quality of life which was unexpected as physical activity and dietary habits are known to improve mental health and QoL in the general population (O'Neil et al., 2014b; X. Wang et al., 2022). However maybe our measures were not specific and precise especially when it comes to the intensity of the physical activity, content of screentime, and the dietary food intake of the children.

We further hypothesized that lifestyle behaviors could mediate the relationship between NDD and emotional problems and QoL, but our results did not show any significant indirect effect. However, the direct effect of NDD remained consistently significant across all tested models suggesting that it was not because children with neurodevelopmental disorders (NDD) follow more sedentary behaviors nor inadequate dietary habits that they have more emotional problems and lower quality of life. This suggested that there would be other mechanisms that could better explain this relation such as the biological and social mechanisms. From biological perspective, previous studies showed how NDD impacts certain regulatory hormones such as those involved in the HPA axis which in turn affect mental health by disrupting emotional regulation and increasing the susceptibility to mood disorders (Bertollo et al., 2025). Social mechanism may also play a role. Children with neurodevelopmental disorders (NDD) suffer from social difficulties and peer rejection. They lack the social skills that enable them to function among other youths (Bunford et al., 2015; Neuhaus et al., 2019).

Finally, it is important to note that this study also provided a comparison between TDC and NDD groups in terms of socioeconomic status, social network/support and health related indicators revealing remarkable socioeconomic and familial disparities. Our findings showed lower

household incomes and more financial difficulties in families with children having NDD compared to those with a TDC. This aligned with a longitudinal study conducted in Canada for a period of 6 years (Rothwell et al., 2022) and other studies in US reflecting the financial disparities between the two groups (Durkin et al., 2010; Nasol et al., 2019). These struggles might also explain our results of the likelihood of children with NDD to have lower parental engagement. Moreover, children with NDD were more likely to come from families whose paternal educational level was lower compared to TDC. This was revealed in other studies linking lower educational level of parents of children with NDD (Torvik et al., 2020b). Also, the findings of this study showed a difference in the family structure where fewer number of children with NDD come from family where parents were living together and this was shown in a study conducted on 391 children with ASD where survival analysis was used to trace the occurrence of divorce (Hartley et al., 2010). Moreover, previous study conducted on 282 children with ADHD showed that parents of children with ADHD were at higher risk of divorce and that many characteristics further shaped that risk such as parental education and conduct problems (Wymbs et al., 2008).

Also, children with NDD were less likely to have siblings when compared to TDC which could be referred to the financial burden and that parents were less likely to live together. Furthermore, results showed that children with NDD were more likely to have parents with depressive symptoms, be exposed to tobacco and have allergy when compared to TDC which aligned with other studies that showed that parents of children with NDD exhibit more parental stress and depressive symptoms (Faden et al., 2023), as well as the association of secondhand smoke with neurodevelopmental disorders (Ou et al., 2024) and allergic conditions (Ji et al., 2025), possibly due to shared inflammatory pathways and environmental exposures (Chua et al., 2021; Elbeeh, 2023).

These results provided important insights for future research to develop on these differences to be able to intervene more specifically in the targeted areas to help improve the emotional problems and lower QoL in children with NDD.

Strengths and Limitations

This research presented several key strengths. The use of the ELFE cohort dataset which is a large high-quality data on children in France provided a detailed information on different aspects of children's health behaviors. Also, the utilization of validated tools like SDQ (Emotional Problems) and VSP-A (for QoL) were used in assessment helped yield reliable outcome assessment. Moreover, this research studied multiple lifestyle dimensions from physical activity to sedentary behavior and finally dietary habits while controlling for parental education, income

and depressive symptoms helped reduce confounding bias. Nevertheless, we need to acknowledge some limitations of our work. The first limitation of the present study was the cross-sectional design that restricted the ability to draw causal inferences where it could only identify associations rather than causal pathways. A longitudinal approach allows us to observe individual trajectories and changes over time in response to lifestyle behaviors. The second limitation was in the generalizability of the findings where it may be limited as they may not reflect characteristics of children living outside France. The third limitation was the reliance on parental reports on lifestyle factors that might introduce potential recall bias and misclassification which could affect the results of this research.

Recommendations for Research and Practice

Further research is needed to explore the impact of different intensity levels of physical activity, the kind of content watched or games played while being exposed to screens, as well as the dietary food habits and choices in impacting mental health and quality of life in children with NDD. It is also important to explore the impact of other factors such as quality of sleep and other comorbidities in shaping these outcomes.

Nevertheless, regardless of the underlying contributing factors, our work has shown that the emotional wellbeing and quality of life in children with NDD is lower than in their TDC peers. Interventional programs to support this vulnerable population could play a crucial role in reducing these issues. The *Kids Brain Health* Network-a Canadian program-focuses on early identification, effective interventions such as adaptive sports and movement-based therapy and family support, which are considered the core challenges in children with NDD ("About," n.d.). In the United States, *Child Mind Institute* aims to transform children's lives especially those who are suffering from mental illnesses, learning disabilities or neurodivergence through providing evidence-based resources and guidance to help families manage screen time, for instance (*Child Mind Institute* | *Transforming Children's Lives.*, n.d.). Meanwhile, *Head Start Programs*-a US-based program-promotes healthy eating and good nutrition through strategies that enable access to nutritious foods especially for families encountering shortage in food supply possibly due to low income including children with disabilities (*Promoting Healthy Eating and Nutrition for Head Start Children and Families* | *HeadStart.Gov*, 2025).

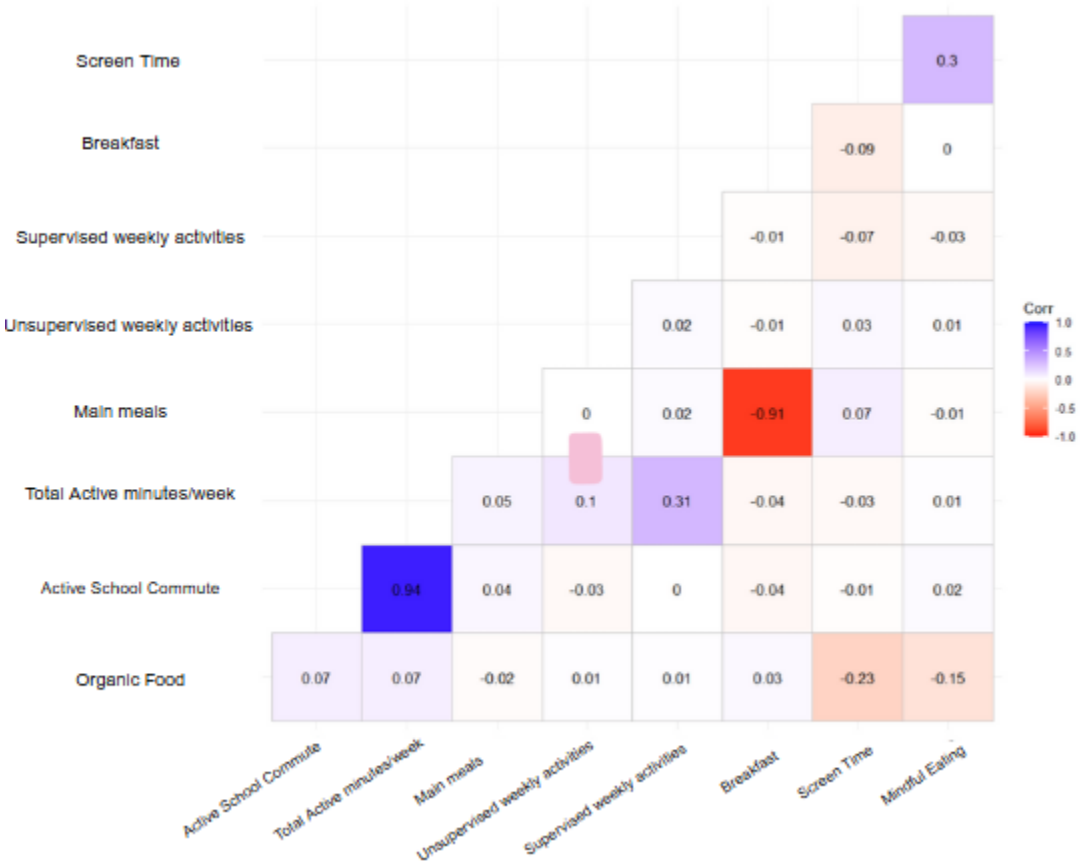
Conclusion

Our research was the first in France to study the impact of NDD on emotional problems and QoL in 10.5-year-old children living in France. We hypothesized that lifestyle factors characterized by

physical activity, screen time and dietary patterns mediate or moderate this relation. The present study revealed that emotional problems and QoL were influenced directly by the disorder rather than lifestyle factors. Public policies should develop programs to reduce the implications of NDD on emotional problems and QoL in adolescents. Future studies should use a longitudinal design to better understand this relation, explore different intensity levels of physical activity, the kind of content watched or games played while being exposed to screens, as well as the dietary food habits and food servings and selections, and identify other mechanisms such as biological and social mechanisms that might be associated with neurodevelopmental disorders and these outcomes.

Appendix

Correlation between lifestyle factors



Appendix 1 – Correlation matrix of lifestyle factors

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