



# Longitudinal Associations Between Cyberbullying Victimization and Cognitive and Affective Components of Subjective Well-Being in Adolescents: A Network Analysis

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## Abstract

In recent years, there has been a notable increase in studies aimed at investigating the relationships between cyberbullying and subjective well-being (SWB) among adolescent populations. Nonetheless, the existing literature on this topic remains relatively sparse. Consequently, this study aims to explore the prospective associations of these constructs through the application of psychometric network analysis. Two cross-lagged network analyses were conducted (Wave 1 and Wave 2), alongside a longitudinal network analysis, encompassing 888 students aged 12 to 16 years ( $M=12.61$ ;  $SD=1.79$ ) from five secondary educational institutions. The results from both cross-lagged networks at both time points revealed significant associations among overall life satisfaction (OLS) and the various domains of life satisfaction, thereby reinforcing the central role of OLS within the network architecture of adolescent well-being. Regarding the affective component of SWB, “happy” emerged as the affect demonstrating the highest level of influence and impact at both time points. Additionally, a robust temporal consistency of the network structure was observed. In the longitudinal network analysis, the trajectories of the variables across time indicated that forms of cyberbullying, specifically “exclusion” and “harassment,” were prospectively and negatively related to “satisfaction with friends” and “satisfaction with body image.” The results of these findings are discussed in terms of their practical implications for the prevention and intervention of cyberbullying in adolescent population.

**Keywords** Subjective well-being · Cyberbullying · Psychometric network analysis · Adolescents

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## Introduction

The subjective well-being (SWB) is regarded as a fundamental adjustment indicator during adolescence (Casas, 2019). SWB refers to the evaluation or the way individuals assess their lives, both in general and in specific domains (González-Carrasco et al., 2020). Specifically, the most utilized theoretical model to assess SWB is Diener's classic model (1984), which distinguishes well-being into two components: an affective component referring to the experience of positive affect (PA) and the absence of negative affect (NA), and a cognitive component that includes the evaluation of one's life as a whole, i.e., overall life satisfaction.

Despite the fact that most studies on SWB are conducted with adult populations, there has been an exponential growth in research on this construct with child and adolescent populations in recent years (For review Dinisman & Ben-Arieh, 2016; Casas, 2019). Adolescence is a period of significant biological, physical, and social changes making it a particularly sensitive developmental period to changes in SWB. For instance, previous studies have indicated a tendency for SWB to decrease from around the age of 10, a trend observed across different countries and using various scales capturing both the cognitive and affective components of SWB (Goldbeck et al., 2007; Casas et al. (2007). In addition to biological and physical changes, the transition from childhood to adolescence is marked by an increase in the quantity and complexity of interactions in various contexts (González-Carrasco et al., 2017a; Fuentealba-Urra et al., 2023).

These data confirm the need for further studies to explore which indicators may be most affecting the fluctuation of SWB during adolescence (Park et al., 2023; Dinisman & Ben-Arieh, 2016). Additionally, it is recommended to assess SWB in adolescents using a variety of instruments to ensure greater robustness (Khatrri et al., 2024).

Even though, following the strategy of capturing the breadth of the cognitive component of life satisfaction (LS), the debate remains open as to whether this is the only way to assess the cognitive components of SWB in children and adolescents; studies often or can include a set of different measures (Gong et al., 2021). Following the recommendations of the International Wellbeing Group (2013), the integration of combined scales emerges as a key element to increase the robustness of SWB assessments. Generally, these are scales or questionnaires that have been used with a single item, with multiple items of individual constructs, and scales that assess domains of life satisfaction through various items. Thus, the single-item scale of Overall Life Satisfaction (OLS) is the most widely used worldwide to assess the global component of life satisfaction. Typically, single-item scales like this are used to represent a global construct and to obtain the subjective perception of multidimensional concepts multidimensionals (Migliorini et al., 2019), representing the level of life satisfaction in a more abstract and less deconstructed manner (Cummins et al., 2003). Similarly, to assess satisfaction in different domains, the Personal Well-Being Index-School Children (PWI-SC) in a version developed by Cummins and Lau (2005), as well as the Student Life Satisfaction Scale (SLSS) by Huebner (1991), are extensively used in children and adolescents. Finally, to measure experienced happiness during the past two weeks, as well as the affective component of well-being, a single-item affective instrument known as the Overall Happiness Scale (OHS) by Diener (1984),

is used, which asks individuals how happy they have felt overall during the indicated period of time.

However, due to the complexity of the construct of subjective well-being in adolescents, multiple instruments based on varied premises need to be applied to integrate the different definitions of the construct and make the assessment more robust (International Wellbeing Group, 2013; Moreta-Herrera et al., 2023; González-Carrasco et al., 2017b). Nevertheless, the incorporation of other measures, such as the PWI, allows the measurement of subjective well-being based on the average satisfaction scores across different domains such as standard of living, health, life accomplishment, relationships, safety, community connectedness, and future security (Cummins et al., 2003). These measures are relevant because their domains are fundamental for the development of children and adolescents, and the unique variation of each contributes to the calculation of overall life satisfaction (Casas, 2011; International Wellbeing Group, 2013; Orúzar et al., 2019).

## Cyberbullying Victimization and SWB

One of the indicators that has shown to have more harmful effects on SWB during adolescence is experiencing bullying (Borualogo & Casas, 2021; Oriol et al., 2021a). However, most studies conducted have linked traditional bullying (face to face) with various SWB scales, but more studies are needed to observe the consequences of cyberbullying experiences (through electronic devices) on SWB during adolescence (Oriol et al., 2021b). Cyberbullying is defined as “an aggressive and intentional act carried out by a group or individual, using electronic forms of contact repeatedly and over time, against a victim who cannot easily defend themselves” (Smith et al., 2008; i Dooley et al., 2009). Moreover, this type of interpersonal violence through electronic devices can occur not only in the school environment but also in any other place and at any time, as long as there is an Internet network available (Smahel et al., 2020), whether to intimidate, harass, or coerce others (Raskauskas & Huynh, 2015). From this, the following components that characterize cyberbullying can be identified: the cyberbully tends to threaten victims; the power disparity between victims and perpetrators; the repetition of aggression, and the sending of unpleasant interactions (Ferrara et al., 2018). Perplexing practices associated with cyberbullying are identified with new terms such as flaming (Internet-initiated discussion that spreads), harassment (repetitive harassment through hurtful messages), denigration (spreading rumours or false messages), impersonation (identity impersonation online to send offensive messages), trickery (spreading secrets through the network), exclusion (intentionally excluding or rejecting someone from a chat or online group), cyberstalking (intensive harassment, espionage, constant sending of false messages, identity impersonation), and happy slapping (recording and spreading assaults) (Santre, 2023). These circumstances in which technological advancements place us are affecting a growing number of adolescents, considered one of the most vulnerable groups in this new environment (Echeburúa & De Corral, 2010).

Cyberbullying among adolescents is considered a serious public health issue closely related to adolescents' behaviour, mental health, and development (Raskaus-

kas & Huynh, 2015). A recent study conducted in the six World Health Organization (2019) regions revealed that 30.5% of adolescents aged 12–17 years were either traditionally bullied or cyberbullied (Biswas et al., 2020). In the United States, over 37% of the adolescents reported being bullied either face-to-face or online (Hicks et al., 2018). A systematic review of studies on cyberbullying revealed that the prevalence of cyberbullying in adolescents ranged from 6.0 to 46.3% (Zhu et al., 2021). These different results show variability between countries; but they may also have been influenced by factors such as the absence of a standardized definition, measurement and nationally representative samples.

Various studies confirm that experiencing cyberbullying has negative effects on many aspects of young people's lives, such as invasion of personal privacy and psychological disorders (Ünal-Aydın et al., 2023; Skilbred-Fjeld et al., 2020). Compared to victims of traditional face-to-face bullying, those bullied online show higher levels of depression, anxiety, and loneliness (Larrañaga et al., 2016), as well as self-esteem issues, suicide, and school absenteeism (Van Geel et al., 2014; Dorol & Mishara, 2021).

Some studies linking cyberbullying with SWB indicators during adolescence show that victims of these forms of interpersonal violence through electronic devices have lower levels of life satisfaction than non-victims (Moore et al., 2012; Arnarsson et al., 2020). It has also been observed with longitudinal data that cyberbullying victimization has negative effects on life satisfaction and an important indicator of SWB during adolescence, such as school satisfaction (Oriol et al., 2021a). In two studies conducted by Schunk et al. (2022) during COVID-19, they observed that cyberbullying victimization also had negative effects on adolescents' life satisfaction.

In sum, existing studies indicate that cyberbullying victimization can also be a very important risk indicator for SWB during adolescence, but there are still many gaps in this area. Studies linking cyberbullying victimization with different measures of adolescent SWB are lacking. Many existing studies have linked cyberbullying with cognitive indicators of SWB, but a better understanding of the relationship with affective indicators is needed. Additionally, longitudinal studies are needed to verify these relationships over time.

### **The Network Analysis Approach for Studying SWB**

As a conceptual and methodological perspective, the Network Analysis approach allows for the analysis of network connections at a more detailed level, focusing on the mutual relationships that occur among psychological phenomena, understood as complex systems of interconnected elements (Blasco-Belled et al., 2024). Therefore, in this type of analysis, it is assumed that the indicators of a network exist because they mutually reinforce each other (Blasco-Belled, 2023). This is a central aspect for analysing the relationships between different constructs, as Network Analysis has a more exploratory character and helps to conduct a deeper analysis of the various relationships observed among these variables within the network (Borsboom et al., 2021). For example, network models are not based on any a priori theory, representing an option to identify alternative mechanisms connecting variables (Marsman et al., 2017); it also measures the centrality or relative importance of each variable in

the network, i.e., the more connections, the stronger and more relevant the variable is in the network (Epskamp et al., 2018; Letina et al., 2019).

In SWB studies, this type of approach can be very useful, considering that it is a complex construct where its structure is still not entirely clear and is under discussion at an international level (Strelhow et al., 2020). In fact, it is recommended to use different instruments for both the cognitive and affective components to capture the construct with the greatest possible robustness (International Wellbeing group, 2013). Therefore, being able to conduct an analysis that allows for exploring the relationships of each item of cognitive and affective components and their relationship with different cyberbullying items becomes an important methodological advantage (Strelhow et al., 2020; Savahl et al., 2024). Network data analysis becomes a powerful tool for obtaining a deeper understanding of the relationships and interconnections between variables within a network structure, to identify underlying mechanisms of well-being, and clarify how different conceptualizations of well-being relate to each other in relation to other indicators (Choi et al., 2021; Wang & Potika, 2021).

## Present Study

This study is exploratory, without starting from a previous model, therefore without making predictions of how or when a certain phenomenon will occur based on the information we have. The general objective of this exploratory study is to identify the connections between cognitive and affective indicators of subjective well-being and cyberbullying in a sample of adolescents. Specifically, through network analysis, the following aims are pursued: (1) To understand the relationships between different indicators of subjective well-being and cyberbullying and to detect the relationships with greater strength and relevance considering two cross-sectional networks of T1 (i.e., the first year of the longitudinal data collection) and T2 (i.e., the second year of the longitudinal data collection). (2) To observe changes in longitudinal patterns, considering the invariance in the cross-sectional networks of T1 and T2 in order to detect changes in the network structure and conducting a longitudinal network analysis enabling a full evaluation of changes in the trajectory of the variables by integrating both individual and group perspectives.

## Method

### Sample

The data for this study were collected at two time points (Wave 1 and Wave 2), from a convenience sampling frame consisting of students aged 12 to 16 years from the 5 secondary schools of the municipality of Lloret de Mar (Girona) during two academic years: 2022–2023 (Wave 1: October 2022) and 2023–2024 (Wave 2: April 2023). At the beginning, all secondary schools in the municipality were contacted and all students were given a consent form for participation in the study that they had to return signed by their parents or tutors. Only students with signed parental consent could participate in the study. All the schools are public except for 1 which is chartered

private. All of them follow the same criteria regarding their educational program and can be considered complex mainly due to the diversity of their students' origins. For Wave 1, the total sample was 1,031 students, being 47% female and 43% male, and the mean age was 12.61 (SD=1.81); For Wave 2, the total sample was 1,144 students being 48% female and 52% male being the mean age 12.43 (SD=1.95). A total of 888 students participated in both data collections. The total number of excluded cases is 143.

Among the reasons for the loss of participants from the sample were the end of compulsory schooling, change of centre in another municipality and illness at the time of data collection. The relevant information has been presented in the previous sections of this document.

## Procedure

Schools were contacted to request their collaboration in a research project aimed at longitudinally examining the well-being of adolescents. Contact was made with 5 secondary schools, of which 4 were public and 1 was private. Participating students provided a signed informed consent form from their parents, although they were also informed that their participation was voluntary and they could withdraw from completing the questionnaire at any time. They were also informed about the confidentiality of their responses. The questionnaires or self-reports were administered in schools through a web-based survey platform called the Well-being Monitoring System (WMS), with the presence of a researcher who previously explained the objectives of the data collection and addressed any questions raised by the students, who had 50 min to complete the self-reports.

## Measures

The self-report questionnaire administered through the WMS web platform consisted of the following scales:

Children's Worlds Domain-Based Subjective Well-Being Scale (CWBS), A total of 10 domains were explored using two psychometric scales, with slight modifications in the wording. The Personal Well-being Index – School Children (PWI-SC) (Cummins & Lau, 2005) included questions on satisfaction with All the things you have, Health, The things you want to be good at, Relationships with people in general, How safe you feel, About doing things away from your home and What may happen to you later in your life, and the Brief Multidimensional Students' Life Satisfaction Scale (BMSLSS) (Seligson et al., 2003) with Family life, Friends, School experience, Own body and The area where you live, in general. Corresponding to T1, it is observed that the reliability indicators are adequate; the alpha reported was 0.86 and the Omega coefficient obtained a value of 0.86. Regarding fit indices, it is reported that for T1, TLI=0.91, CFI=0.93 and a RMSEA=0.08 ( $\chi^2 = 3123.932$ ,  $p < 0.05$ ). For T2, it is reported that the reliability indicator corresponding to Cronbach's alpha is 0.88 and an Omega coefficient of 0.88; as for the AFC fit indices, a CFI=0.93, TLI=0.91 and RMSEA=0.08 ( $\chi^2 = 3416.376$ ,  $p < 0.05$ ) are reported.

OLS (*Overall Life Satisfaction*). This 5-item self-report assesses individuals' judgments about their satisfaction with life overall on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). A sample item is "In most ways, my life is close to my ideal." (Diener et al., 1985).

PNAS (P and N), Scale that assess positive and negative affect (Watson et al., 1988; Feldman Barrett & Russell, 1998; Russell, 2003). Evaluated as two dominant and relatively independent dimensions, through 6 items, of which 3 measure the positive affective state (happy, cheerful, calm) and 3 measure the negative affective state (stressed, tired, anxious). All affects were measured based on responses ranging from 0 (not at all) to 10 (all the time), in response to the question "... mark the box that best describes how you have felt during the past 2 weeks". Regarding the positive affect scale, it is observed that for T1 the Omega reliability indicator reported is 0.83 and Cronbach's alpha is 0.79; for negative affect an Omega coefficient of 0.76 and a Cronbach's alpha of 0.75 is reported. Evaluating the CFI fit indices for T1, we report a TLI of 0.97 and a CFI of 0.98; and a RMSEA of 0.048 ( $\chi^2 = 2151.491$ ,  $p < 0.05$ ). On the other hand, for T2 of the positive PNAS, an Omega coefficient of 0.82 and a Cronbach's alpha of 0.78 are reported; in the case of the negative PNAS, an Omega coefficient of 0.78 and a Cronbach's alpha of 0.78 are reported; as for the validity indicators for T2 of the PNAS, a CFI of 0.97 and a TLI of 0.97 together with an RMSEA of 0.07 are reported.

Cyberbullying: The Childrens World Cyberbullying scale has 3 items such as Have you been laughed at on social networks (WhatsApp, Telegram, Instagram, TikTok...) by other boys or girls or from school/high school...? Have you been excluded or ignored in a chat or a social network (WhatsApp, Telegram, Instagram, TikTok...) by other boys or girls from school/high school? and Have rumours been spread about you on the internet or any social network? (WhatsApp, telegram, Instagram, TikTok...)?, which is evaluated on a scale ranging from 0 to 3, with 0=Never and 3=More than 3 times. For T1, an Omega coefficient of 0.74 and a Cronbach's alpha of 0.74 are reported, For T2 the Omega coefficient was 0.81 and a Cronbach's alpha was 0.82.

## Data Analysis

We identified longitudinal changes in the composition of the components of adolescent well-being using network psychometric analysis. We related cross-sectional node changes to longitudinal network changes, which is a similar strategy to that used by Miers et al. (2020) and Von Klipstein et al. (2021). Listwise deletion was utilized to handle missing data because the estimation of the longitudinal network requires that there be no missing items in the input matrix. This indicates that the study only included participants who finished the self-reports at T1 and T2. The decision was made to use listwise deletion instead of pairwise selection since the latter requires making assumptions about the mechanisms underlying missingness (i.e., whether data is missing at [totally] random or not), which are not currently verifiable in network models. RStudio was used for all analyses (Team, 2020).

## Network at T1 and T2

In order to represent how the variables influence one another, we first estimated the cross-sectional networks of T1 (i.e., the first year of the longitudinal data collection) and T2 (i.e., the second year of the longitudinal data collection) as pairwise Markov random fields (Shah et al., 2021). This is a graph where nodes represent indicators and edges represent partial correlations.

In contrast, the absence of an edge between two variables suggests that there is no association given all other items in the estimated network, indicating conditional independence. This indicates that a connection between two variables cannot be explained by any other variable in the estimated network (i.e., conditional dependence). This does not mean that the relationship between two network variables cannot be explained by any other variable that is not part of the network, such as environmental factors.

In a network of partial correlations, if variables A and C are only correlated because of B, the association between A and C should be zero when B is present. However, networks can sometimes estimate these correlations as weak nonzero edges. These are known as spurious associations or false positives, which are edges that are in fact not present in the network. To prevent this from occurring, statistical regularization techniques are used to limit the number of spurious edges. In order to create a sparse network with as few connections as feasible, we employed the graphical “least absolute shrinkage and selection” (LASSO; Friedman et al., 2008) method, which shrinks all edges and sets small edges to zero (Epskamp & Fried, 2018). To choose the best model, we applied the extended Bayesian information criteria (EBIC; Chen & Chen, 2008).

The bootnet R-package version 1.4.3’s `estimateNetwork` function was used to estimate networks (Epskamp et al., 2018). The R-package `qgraph` version 1.6.9 was utilized to visualize networks (Epskamp et al., 2012). We employed fixed node placement in the longitudinal network visualization at T1, T2, and the network visualization at T1 by averaging the layout with the function `averageLayout` of the `qgraph` R-package, which constrains the Fruchterman & Reingold (1991) layout to be equal. This allowed for easier visual comparison.

We utilized the `MDSnet` feature of the `networktools` R-package version 1.4.0 (Jones et al., 2018). The `centralityPlot` function of the `qgraph` R-package was used to evaluate the significance of each node in the network, specifically determining which nodes had a stronger influence on other nodes. The metric of node expected influence was selected instead of node strength because it is more suited for measuring the extent to which a node is related to other nodes in a network that includes both positive and negative edges (Robinaugh et al., 2016). An analysis was conducted to assess the accuracy of the estimated parameters in each network by examining the stability. This was done by considering the edge weights (correlation coefficients), the order of centrality (the importance of nodes in the network), and conducting a difference test to determine if two edge weights significantly differ from each other. The `bootnet` function from the `bootnet` R-package version 1.5 was utilized to examine the stability of the network topology, namely the edge weights and difference test. This was achieved by employing a nonparametric bootstrap method with 1000 samples.



Nonparametric bootstrapping is the process of resampling data with replacement to generate new datasets (Epskamp et al., 2018). Analysed utilizing the CS-coefficient, the stability of the centrality parameters was assessed. Using the bootstrap technique, the network is recalculated with progressively less examples to determine if the order of the centrality estimations is unchanged. The CS-coefficient quantifies the percentage of cases (i.e., individuals) that can be removed while maintaining a  $r=0.70$  between the original network and the resampled network (which has fewer cases). Values greater than 0.25 indicate that the ranking of centrality is interpretable (Epskamp et al., 2018).

## Network Comparison

The networks at T1 and T2 were compared to assess potential disparities in three key aspects: network topology, edge strength, and global strength. The network comparison test (NCT; Van Borkulo et al., 2022) was utilized to examine invariance by comparing these three parameters across the cross-sectional networks. Notable findings suggest that there were variations in the networks over time. These variations could be observed in the overall structure of the network, the strength of connections between nodes, or the total strength of the network. On the other hand, when there were no significant differences, it indicates that the networks remained unchanged across the two time points. In order to ensure a fair comparison between networks, the NCT only considered people who responded to all items in the model at both T1 and T2.

## Results

The descriptive statistics of the two waves, for subjective well-being and cyberbullying, highlight that the items or variables that differentially influence the production of subjective well-being with higher averages, both at the initial moment (T1) and 6 months later (T2) are those that refer to the people with whom you live, neighbourhood, place of residence and friends, together with that of happiness. On the contrary, the lowest ones, at both T1 and T2, are nervous and the items related to cyberbullying, negatively related.

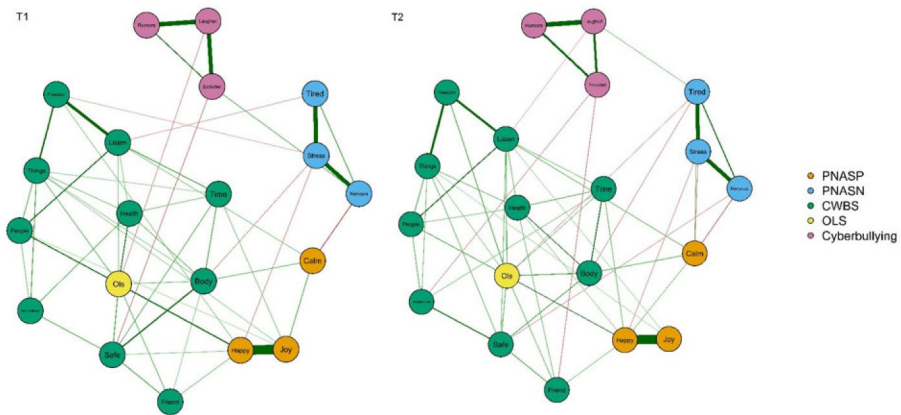
The variables included in the longitudinal network are represented by their descriptive statistics in Table 1; As observed, the values presented in the scores of the items for both waves show very little difference between them; furthermore, there is no evidence of higher scores in one wave compared to the other wave.

During this stage, we analysed the structure of the networks at the initial time point (T1) and six months later (T2). The networks are illustrated in Fig. 1; a fixed node location was employed to facilitate comparison between time-point observations. There were commonalities in the pattern of associations between the two networks. According to the information in Fig. 1, negative affect, positive affect and cyberbullying behaviour was observed as a distinct component, overall life satisfaction and domain-based life satisfaction, were integrate to each other, while being categorized as separate components. The nodes representing positive affect (such as “happy”,

**Table 1** Descriptive statistics for subjective well-being and cyberbullying variables included in the Longitudinal Network

	M	SD	Skewness	Kurtosis	Min	Max
Time 1						
Happy	7.84	1.837	-1.306	2.188	0	10
Joy	7.92	1.795	-1.129	1.550	0	10
Calm	6.73	2.449	-0.735	0.043	0	10
Stress	5.01	3.081	-0.140	-1.208	0	10
Tired	5.73	3.019	-0.402	-0.949	0	10
Nervous	4.33	3.005	0.064	-1.115	0	10
The people you live with	8.96	1.643	-2.018	4.271	1	10
The neighbourhood or area where you live	8.61	1.813	-1.898	4.359	0	10
How safe you feel	8.21	1.950	-1.492	2.621	0	10
Your friends	8.54	1.839	-1.829	3.930	0	10
How you use your time	7.34	2.225	-1.101	1.081	0	10
Your own body (appearance)	7.19	2.655	-0.991	0.292	0	10
All the things you have	8.79	1.517	-1.657	3.228	1	10
The freedom you have	8.27	1.980	-1.527	2.389	0	10
How adults listen to you in general	7.68	2.241	-1.330	1.600	0	10
Your health	8.72	1.746	-1.962	4.426	0	10
Your life in general	8.44	1.754	-1.581	3.151	0	10
They have laughed at you on social networks	0.83	1.445	1.493	0.553	0	4
You have been excluded or ignored in a chat or social network	0.79	1.325	1.530	0.873	0	4
They have spread rumours about you on the internet or some social network	0.85	1.534	1.430	0.211	0	4
Time 2						
Happy	7.78	1.841	-1.106	1.619	0	10
Joy	7.84	1.831	-1.131	1.612	0	10
Calm	6.66	2.488	-0.687	-0.120	0	10
Stress	5.43	3.108	-0.284	-1.157	0	10
Tired	6.09	3.019	-0.538	-0.774	0	10
Nervous	4.44	3.028	0.026	-1.146	0	10
The people you live with	8.96	1.664	-2.212	5.736	0	10
The neighbourhood or area where you live	8.57	1.851	-1.900	4.468	0	10
How safe you feel	8.24	1.882	-1.581	3.223	0	10
Your friends	8.57	1.805	-1.983	5.044	0	10
How you use your time	7.28	2.242	-1.028	0.947	0	10
Your own body (appearance)	7.27	2.606	-1.056	0.500	0	10
All the things you have	8.76	1.525	-1.688	3.931	0	10
The freedom you have	8.12	2.106	-1.537	2.549	0	10
How adults listen to you in general	7.60	2.286	-1.253	1.398	0	10
Your health	8.58	1.857	-2.102	5.494	0	10
Your life in general	8.34	1.781	-1.588	3.399	0	10
They have laughed at you on social networks	0.90	1.516	1.348	0.066	0	4
You have been excluded or ignored in a chat or social network	0.76	1.315	1.625	1.199	0	4
They have spread rumours about you on the internet or some social network	0.93	1.597	1.284	-0.208	0	4

Note Only those participants who responded to all questions at T1 and T2 were included



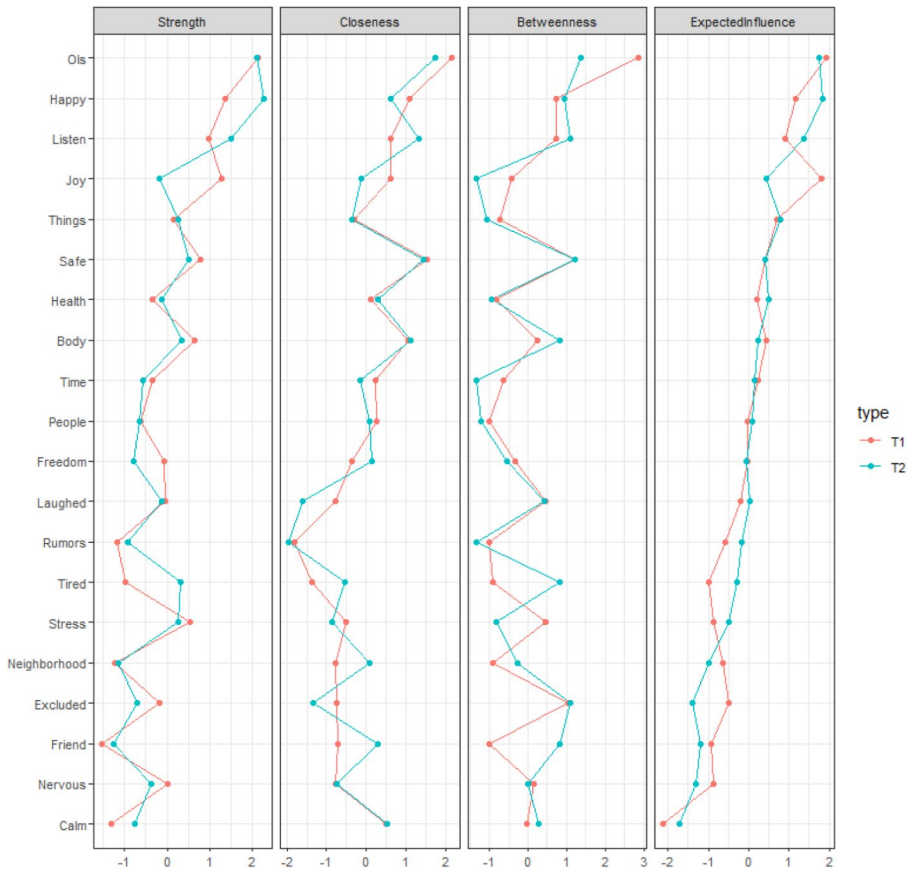
**Fig. 1** Network structure of Adolescents' Well-Being and Cyberbullying at T1 and T2

“calm”, and “joy”) were positioned between nodes representing satisfaction with different life domains (such as “Satisfied with the time you have”, “Satisfied with your appearance”, “Satisfied with your friends”) and some of negative affects such as “Nervous”. At both T1 and T2, a notable trend was observed in the networks, where there was a significant association among the OLS and among the different domains of life satisfaction.

The strength, closeness, betweenness, expected influence of nodes, which denotes the level of influence and impact that each variable has on the other variables in the network, exhibited a significant degree of similarity in both networks (Fig. 2). The most prominent nodes were the OLS (overall life satisfaction), with a secondary focus on positive affects such Happy. Conversely, experienced calm had the least impact on both networks. The networks were highly stable and the predicted parameters, including edge weights and expected influence, were highly accurate.

The correlation stability was 0.75 at T1 and 0.67 at T2, suggesting that in at least 75% and 67% of cases, respectively, the correlation between the estimated and replicated values might decrease below 0.70. These findings suggest that one could interpret the centrality estimations among different networks. The centrality estimations between T1 and T2 exhibited a strong positive correlation ( $r=0.66$ ), providing evidence for the consistency of the network.

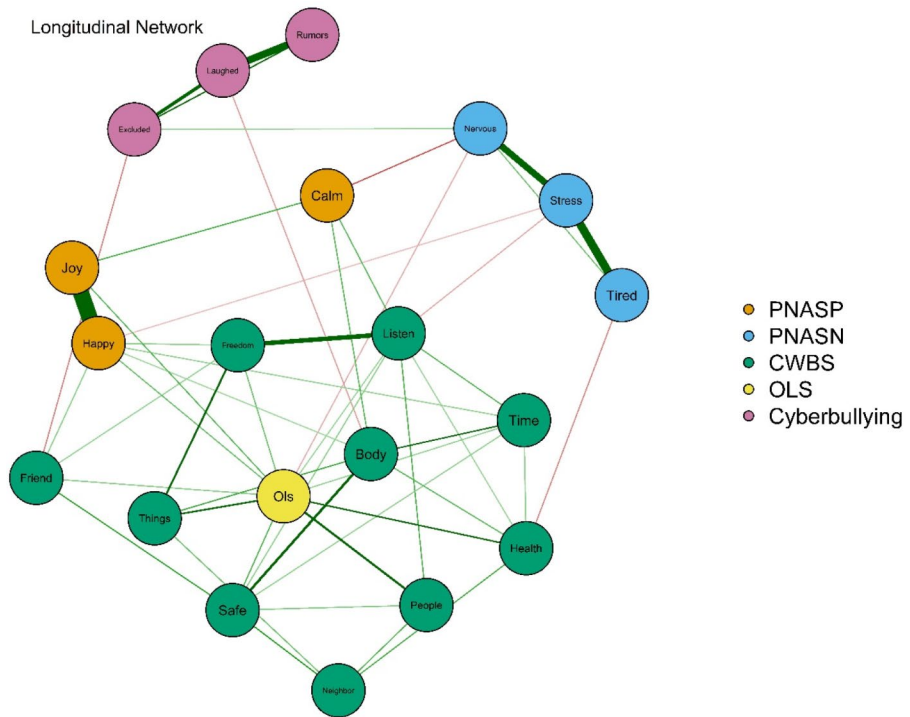
We conducted a comparative analysis of the network structure using the NCT to assess the consistency of the network across time, before investigating the longitudinal relationships. The findings indicated that there were no significant variations between T1 and T2 in terms of the network structure ( $M=0.18, p=0.35$ ) and global strength ( $S=0.33, p=0.10$ ). There were no statistically significant differences in the expected influence centrality metric (all  $p$ -values  $>0.05$ ), indicating that the network is robust.



**Fig. 2** Comparing centrality Indices of all Items between T1 and T2

### Change in the Longitudinal Patterns

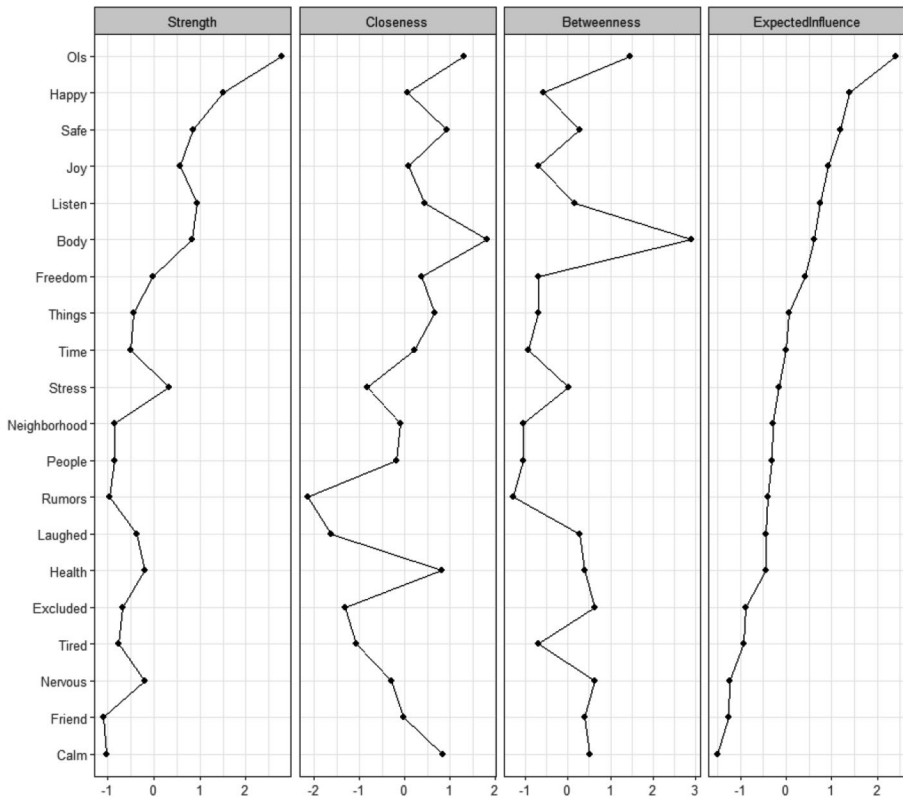
Figure 3 depicts the longitudinal network, which is also referred to as the random slopes network. The longitudinal network analysis incorporates the changes of each participant in each variable across time, enabling a full evaluation of changes in the trajectory of the variables by integrating both individual and group perspectives. The results revealed a connection between changes in subjective well-being indicators among them, specially between CWBS indicator with OLS. Two single nodes among the cyberbullying scales inside the longitudinal network exhibited associations with positive and negative affects and CWBS items but not with OLS. Regarding cyberbullying nodes changes, there was a negative correlation between changes in being excluded in social networks and changes to be satisfied with your friends over time, also changes in being excluded has a positive correlation with changes in being nervous. Also, It is shown a negative correlation between changes in being laughed in social networks and changes in the satisfaction with your body (Fig. 4).



**Fig. 3** Longitudinal Network of Adolescents' Well-Being and Cyberbullying behaviour incorporating Participants' Changes in Each Item (with Fixed Node Placement)

On the relationship of the changes of the positive indicators, it is observed that the change of the indicator in Happy (PNASP) present a positive correlation with the nodes of changes in satisfaction with friends, satisfaction with freedom, satisfaction with their body, all of them indicators of CWBS; likewise, a correlation is reported with the change of OLS. This suggests that as adolescents experience an increase in different domains and OLS, they also tend to experience and increase of Happiness. The Joy node has a positive correlation with the increase of OLS; finally, the change in the Calm node has a correlation with changes in satisfaction with how adults listen to them (CWBS), and satisfaction with their body (CWBS), and presents a negative correlation on the change they experience of being nervous (PNASN).

The study also found that changes in the Nervous node (PNASN) presented a negative correlation with changes in OLS, as well as changes in the Stress node (PNASN) over time; finally, being Tired (PNASN) had an effect on the change in health satisfaction (PNASN). This suggests that changes in satisfaction in the different domains affect the level of negative affect experienced. Finally, the change experienced in the OLS node has a positive correlation with changes in The freedom you have (CWBS), All the things you have (CWBS), The people you live with (CWBS), How safe you feel (CWBS), Your health (CWBS) and How you use your time (CWBS) domains. Corroborating the findings for T1 and T2, the nodes that exerted the most influence in the longitudinal network were the nodes associated with OLS and feeling Happy.



**Fig. 4** Comparing centrality Indices of all Items in Longitudinal Network

The stability of the longitudinal network and the computed parameters exhibited a good level of reliability. The CS-coefficient fell below the recommended level of interpretation ( $>0.25$ ), indicating that 42% of cases may need to be removed in order to maintain a correlation coefficient ( $r$ ) of 0.65 with 95% confidence between the original and derived centrality estimations. The correlation coefficient between the weighted matrix of the longitudinal network and the T1 network was 0.73, while the correlation coefficient between the weighted matrix of the longitudinal network and the T2 network was 0.62. The centrality estimations of the longitudinal network exhibited a substantial correlation with the centralities at both T1 ( $r=0.82$ ) and T2 ( $r=0.78$ ), suggesting that the network maintained its consistency across time.

## Discussion

The aim of the present study is to explore how subjective well-being indicators and cyberbullying indicators are interconnected in an adolescent sample through network analysis and to verify the existence of changes and stability in the network across time. The novelty of this study lies in two important aspects to consider. The first is that most previous studies linked traditional bullying victimization with SWB, but

still few studies have related victimization through electronic devices to this form of well-being during adolescence (e.g., Oriol et al., 2021b; Schunk et al., 2022). On the other hand, this study exploratorily observes the interaction and relationship between the affective and cognitive components of SWB, cyberbullying through network analysis, and simultaneously checks the stability of these network relationships through scores collected for time 1 (T1) and time 2 (T2).

In general terms, in this study, the results of the overall view of the relationships and longitudinal changes between the variables of the global sample show that dyadic connections are high and close between feeling “happy” and “joy” (the strongest), and also between types of cyberbullying such as denigration (“They have spread rumours about you on the internet or some social network”) and harassment (“They have laughed at you on social networks”), especially at T2. At T1, a high and close connection is also observed between this latter harassment item and the exclusion item (“You have been excluded or ignored in a chat or social network”), where the edges are stronger than with other items in its subscale. At T1, positive relationships are also observed in the network with the negative affect item “nervous”, while also negative connection with “satisfaction with how safe you feel”. However, this connection is not present at T2, and the form of cyberbullying by exclusion is also negatively connected with “satisfaction with your friends”. The negative linkage at T1 between “exclusion” and “safety”, and at T2 between “exclusion” and “satisfaction with friends” can be explained from the perspective of changes in social roles and biological growth that occur in adolescence (Sawyer et al., 2018), considered a critical phase during which significant physical, mental, and emotional changes occur, constituting the basis for adult health (Melguizo-Ibáñez et al., 2023). Adolescents usually have greater control over their activities, and their level of well-being is closely linked to their activities and substantial changes in their social environment (Blakemore & Mills, 2014).

Exclusion relates to the significance of being excluded from a group during adolescence; the time spent with peers increases from childhood to adolescence, and adolescents’ evaluation of their social and personal worth is more influenced by what their peers think of the (Foulkes & Blakemore, 2016; Lam et al., 2014). However, struggling to respond to these demands explains the negative link with security. Regarding relationships between exclusion and security, prior research suggests that individuals have a fundamental need to feel secure, and when this need is met, it predicts greater well-being, whereas its absence predicts decreased well-being (Ryan & Deci, 2000; Porges, 1995; Woody & Szechtman, 2011). Additionally, previous work has emphasized the virtues of security as a central, unifying concept capable of connecting a diverse array of seemingly disconnected topics under a single explanatory framework (Hart et al., 2005; Lemay & Dudley, 2011). Conversely, the feelings that arise during adolescent development can create and exacerbate feelings of insecurity in their lives, which if excessive, can have a negative impact on mental health (Rahadjeng & Siregar, 2021). For example, in this sense, an initial exploratory hypothesis would be that providing adolescents with techniques to manage insecurity will allow them to feel more prepared to manage their concerns. That is, it may be possible to target specific associations between nodes instead of intervening in individual nodes to change the structure of the network (Borsboom et al., 2021). However, since net-

work relationships reproduce reciprocity but not directionality, the reverse could also be considered: providing support to resolve their concerns would help them feel less insecure. Violent behaviors such as school bullying can have a negative impact on students' perception of psychological safety, and for these victims, school is no longer a safe place, affecting loneliness and their sense of belonging to the school.

As for the items of negative affect (“tired”, “stress”, and “nervous”), which also have strong edges among them, they cover the negative symptomatology related to cyberbullying. On the other hand, contrary to the implicit assumption about the homogeneity of nodes in positive affects, the item or entity of “calm” appears separately in the network of elements constituting its cluster or community, suggesting that it differs in nature from other affects. This has already been observed in cross-cultural studies assessing positive affects in different cultures, where it is noted that positive affects of neutral intensity, such as calmness, are much more prevalent and attributed greater significance in Eastern countries, whereas they are less prevalent in Western cultures (Tsai, 2007; Casas et al., 2020). This, we believe, explains the observed results regarding the behaviour of this affect within the network in this sample.

The OLS (Global Life Satisfaction) stands out due to its centrality in the network regarding its connections with other variables (number and intensity of connections) and its central or dominant position within the network structure of adolescents' well-being, thus assuming the role of network connector. Furthermore, the strength of centrality in both T1 and T2 indicates that satisfaction in life aspects such as “feeling safe”, “appearance, own body”, “own health”, “people one lives with”, and “friends” are the most central nodes. These aspects take into account both individual variables related to positive and negative affect and life satisfaction (security, appearance, health, and happiness), as well as variables related to the environment (people one lives with, friends). In this sense, the relationship between well-being and variables of self-concept and quality of social relationships established by adolescents with family and friends is considered important (Meier & Oros, 2019; Lucks et al., 2020).

Finally, it is worth noting that longitudinal network analysis showed a good level of stability, and the network maintained its consistency across time. The analysis of trajectory change in the longitudinal model suggests that an increase in different domains of subjective well-being contributes to increased happiness and the “Joy” node, as well as the “calm” node associated with “how adults listen to them” and “satisfaction with their own body”. Conversely, the relationship of the “calm” node is inversely related to the experience of feeling “nervous” or “anxious”. Similarly, regarding the directional effects over time of negative indicators, the form of cyberbullying related to “feeling excluded through social networks” decreases “satisfaction with friends”, as well as the form of cyberbullying corresponding to “being laughed at on social networks”, worsens “satisfaction with one's own body”. These data contribute to reinforcing our specific understanding of the longitudinal impact that various forms of cyberbullying can exert on critical aspects of well-being and mental health during this developmental phase, particularly those linked to self-image, social integration, and peer acceptance (Blakemore & Mills, 2014; Choukas-Bradley et al., 2022).



In relation to what has been exposed, two strong bridges have been identified in Blinka's et al. study (2023), which are potential candidates for intervention in both boys and girls: firstly, the traditional victimization of bullying school connected the group of bullying experiences with psychosocial difficulties; and, secondly, lack of sleep or frequent meals due to Internet use. In conclusion, the results provide guidance for the preventive and intervention work of professionals dealing with adolescents, as well as complex gender comparisons for the interrelationships of problematic Internet and smartphone use, the experiences of 'school bullying and the psychosocial difficulties of young people. Additionally, this study provides evidence that problematic digital media may play a role in bullying experiences, regardless of whether the bullying occurs offline or online. Also, negative emotional states and types of cybervictimization were related in a complex network where efforts to approach reduction of emotional symptoms associated with cybervictimization could produce lasting benefits for the emotional wellbeing of youths (Xia et al., 2024).

Such insights and a marked prevalence of cyberbullying in high school students, underscore the importance of implementing targeted interventions aimed at mitigating these effects among victims, as well as proposing preventive strategies to raise awareness and deter cyberbullying occurrences during adolescence.

## Limitations

This study also has its limitations. Firstly, it is important to consider gender differences that may exist. The objective of this study was to verify the relationships between cyberbullying and components of SWB in adolescence and to check the stability of the network across time. However, for future studies, it will also be necessary to observe the existence of invariance in the network due to gender reasons. It is also important in future studies to incorporate other sociodemographic data that allow for a broader understanding of the influence of these more environmental and socio-cultural factors in shaping the nodes and relationships within the network. As a limitation of the study, it is also important to note that the cyberbullying questionnaire used consists of three items and that in the future, other questionnaires should also be used to capture more broadly the different types or practices in addition to the multiplicity of forms of violence through electronic devices that currently exist and their relationship and interaction with SWB through this type of analysis.

Time perspective has been recognized as an important psychological dimension with a pervasive and powerful influence on human behaviour. Thus, a limitation in this study is not having focused on the relationship between temporal perspective and cyberbullying behaviour, and filling this gap by investigating the relationship between different temporal perspectives and both cyberbullying and cybervictimization.

It is also necessary to consider for other future research and theoretical foundations oriented to the detection of cyberbullying in social networks in the era of Big Data using machine learning and natural language processing algorithms, due to the growing need for detection and automatic mitigation of cyberbullying events in social networks, designing a framework that takes into account all possible actors in the cyberbullying event, including various aspects of cyberbullying and its effect on participating actors.

Finally, a cautious attitude should also be adopted in interpreting the network and the centrality of nodes. This type of analysis does not aim to verify causality between variables, and therefore, it allows us to observe exploratively the relationships within the network, providing very relevant information regarding the interaction between these variables. However, studies that complement this type of analysis should continue to be conducted.

## Conclusions

This study has demonstrated how the use of metrics extracted from network science can enrich understanding of how interactions between cyberbullying and subjective well-being are affected. A network view of this data entails different theoretical implications that can contribute to intervention design. The estimated network indicated that strengths in security, perception of freedom, body image, the people one lives with, and active listening from adults, connected the communities of subjective well-being strengths. The associations between these specific strengths and subjective well-being may represent viable targets in interventions aimed at promoting subjective well-being.

On the other hand, the study using network analysis has allowed the identification of which forms of cyberbullying are most related to indicators of subjective well-being across time. In this sense, the results indicate that forms of cyberbullying associated with harassment and exclusion exhibit negative relationships across time with highly relevant indicators for adolescent well-being and self-esteem, such as satisfaction with body image and satisfaction with friends. This prompts considerations for: (1) the necessity of implementing specific interventions targeting cyberbullying victims aimed at bolstering their self-image and peer support networks to mitigate social exclusion. (2) Promoting group-based prevention programs and interventions among adolescents in educational institutions focused on elucidating cyberbullying and the various forms of aggression facilitated through electronic devices, while raising awareness about the consequences these actions entail, particularly concerning aspects related to social comparison such as self-image and peer social exclusion, thereby emphasizing the importance of reporting such instances and providing support to victims when they occur.

The narrative review points to possible strategies for cyberbullying intervention, including strategies in empathy training (Ang, 2015) such as the Finnish KiVa program (Williford et al., 2013) or the German Empathy training (Schultze-Krumbholz et al., 2016); educational campaigns (Chisholm, 2014) or programs developed through collaborative work with adolescent participants with interviews, group discussion and role-playing (Ashktorab & Vitak, 2016) such as the Italian program NoTrap! (Palladino et al., 2012) where teenagers can use the program to turn their feelings against cyberbullying into actions.

Despite these techniques and approaches to prevent and/or reduce cyberbullying perpetration and victimization, there is a current gap in the literature on extensive systematic reporting and meta-analytic reviews of the effectiveness of cyberbullying intervention programs. Therefore, implementing strategies that go beyond mere

academic excellence, with prevention programs that foster well-being as a protective factor in optimal and meaningful youth development, becomes a priority goal.

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