Treasuring teen friendships: behavioral and neural mechanisms underlying adolescent learning and mental health in the peer context

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Chapter 5

Adolescents' friendship quality, internalizing problems, and academic achievement during the COVID-19 pandemic: a longitudinal study

This manuscript is in revision and has been preprinted as:

Koele, I. J., Blankenstein, N. E., Schreuders, E., van Duijvenvoorde, A. C. K., & Güroğlu, B. (2023). Adolescents' Friendship Quality, Internalizing Problems, and Academic Achievement during the COVID-19 Pandemic: A Longitudinal Study.

https://doi.org/10.21203/rs.3.rs-2653418/v1

ABSTRACT

Background: The COVID-19 pandemic substantially influenced adolescents lives and possibly also their cognitive and mental health outcomes. In our longitudinal study, we investigated possible changes in adolescents' academic achievement and internalizing problems across two academic years during the COVID-19 pandemic. Specifically, we examined whether adolescents' friendship quality buffers against possible changes in academic achievement and internalizing problems during the pandemic.

Methods: Our study sample consisted of Dutch young adolescents aged 11-16 (N_{T1} = 250) who filled out questionnaires on their friendship quality and internalizing problems during four data collection points across two academic years. Timepoint 1 (T1; November 2019) was before the COVID-19 pandemic, and the subsequent data collection points during the COVID-19 pandemic (T2: May/June 2020, T3: November/December 2020, T4: May/June 2021). Academic achievement was measured with school records of report grades. We conducted linear mixed models to analyze the data.

Results: Our findings showed that academic achievement decreased over time, and internalizing problems increased over time across two years during the COVID-19 pandemic. Furthermore, we found that adolescents with better (i.e., higher positive and lower negative) friendship quality had fewer internalizing problems. This significant relationship between better friendship quality and fewer internalizing problems held across all timepoints (pre-pandemic and during the COVID-19 pandemic).

Conclusion: Together, our findings provide insights into the adverse effects that the COVID-19 pandemic has had on adolescents' academic achievement (decrease over time) and internalizing problems (increase over time), which could be considered by future governmental policies on lockdowns and restrictions during a crisis, such as the pandemic. Additionally, our results provided support for the general significance of friendship quality for adolescents' mental health (i.e., internalizing problems).

Keywords: adolescence, COVID-19, friendship quality, internalizing problems, academic achievement

1. INTRODUCTION

On February 27, 2020, the first COVID-19 case was confirmed in the Netherlands. The COVID-19 pandemic has had substantial influence on adolescents' lives impacting their academic achievement, mental well-being, and friendships (Barendse et al., 2022; Bernasco et al., 2021; Klootwijk et al., 2021; Li et al., 2021; Panagouli et al., 2021; Romm et al., 2021). Adolescence is characterized by increased importance of peers, especially close friends, and friendships have wide-ranging benefits for adolescents (Bukowski et al., 2009; Furman & Buhrmester, 1992). Friendship can be defined as a strong reciprocal emotional bond between two individuals, characterized by reciprocity in liking, affect, and behavior (Bukowski et al., 2009; Hartup & Stevens, 1997). High quality friendships are generally distinguished by many positive features (e.g., security, intimacy) and few negative features (e.g., conflict, rivalry) (Berndt, 2002; Bukowski et al., 1994). With age, adolescents increasingly depend on friends for their social support (Bukowski et al., 2009; Hartup & Stevens, 1997), which suggests that friends could play a crucial role in cognitive and mental health outcomes of adolescents, especially during a crisis such as a pandemic. Pre-pandemic research has indeed demonstrated that high friendship quality is related to higher academic achievement and fewer internalizing problems in adolescents (Sebanc et al., 2016; Waldrip et al., 2008). However, little is known on the protective role of friendship quality on adolescents' academic and internalizing outcomes during the COVID-19 pandemic. In the current study, our two main goals were to examine the possible changes in adolescents' academic and internalizing outcomes during the COVID-19 pandemic, and whether friendship quality would buffer against these changes in academic and internalizing outcomes.

The pandemic has brought along many changes in adolescents' lives due to not only the lockdowns and the closure of the schools but also due to the many social and societal restrictions that have been set in place. For many adolescents, schools and extracurricular activities serve a highly social function where they can socialize with their friends. Not being able to see their peers at school and not being able to meet with them outside of school, adolescents' lives have been largely restricted during the first two years of the pandemic. As such, the COVID-19 pandemic can be regarded as a stressful period. Prior research has demonstrated that friendship quality can have a protective effect on academic achievement and internalizing problems for adolescents who experienced stressful life events. A previous study has for example shown a protective effect of high levels of friend support on academic achievement in adolescents who experienced a stressful life event (i.e., bullying) (Rothon et al., 2011). Additionally, prior research has revealed that friendship quality is related to reduced subsequent depressive symptoms in adolescents who experienced a stressful life event (e.g., peer bullying and emotional neglect) (Van Harmelen et al., 2016; Zhao et al., 2021). Multiple studies examined the impact of the family and home context (e.g., parenting, financial stress) on children and adolescents' academic achievement and internalizing problems during the COVID-19 pandemic (e.g.,

Cohodes et al., 2021; Haelermans et al., 2022; Liang et al., 2021; Liao et al., 2022; Low & Mounts, 2022; Westrupp et al., 2021). However, few studies examined the influence of the support system outside the family (e.g., friendship quality) on adolescents' internalizing problems during the COVID-19 pandemic. To our knowledge, studies are also lacking on the influence of friendship quality on adolescents' academic achievement during the pandemic. Furthermore, few studies examined the long-term changes in adolescents' academic and internalizing outcomes across the COVID-19 pandemic.

Academic outcomes of children and adolescents were affected by the pandemic. At the start of the pandemic researchers predicted that the school closure during the COVID-19 pandemic would lead to a learning loss in children and adolescents, based on pre-pandemic absenteeism literature and analyses of summer learning patterns (Kuhfeld et al., 2020). Adolescents indeed reported a negative impact on learning (Li et al., 2021) in the beginning of the pandemic (June-Aug 2020). Furthermore, a systematic review including 42 studies has shown that children and adolescents experienced learning losses during the pandemic compared to pre-pandemic years (Panagouli et al., 2021). However, almost all 42 studies included in the systematic review examined academic achievement in children and/or adolescents in the beginning of the pandemic in 2020, except for three studies which included data from 2021. Furthermore, most studies from the systematic review used self-report or parent-report questionnaires to measure academic achievement, instead of a more objective measure such as test scores or school records. In addition, according to a pre-pandemic systematic review on the influence of learning strategies on academic achievement in online learning environments, peer learning should be prioritized in online learning contexts (Broadbent & Poon, 2015). However, to our knowledge, research is lacking on the possible protective influence of close friends (i.e., friendship quality) on adolescents' academic achievement across the COVID-19 pandemic.

Mental health outcomes of adolescents were also affected by the pandemic. Prior research during the COVID-19 pandemic has shown that adolescents experienced more internalizing problems, such as feelings of depression and anxiety (Ellis et al., 2020; Li et al., 2021; Weissman et al., 2021). Two prior studies demonstrated that higher pre-COVID-19 pandemic friendship quality was related to fewer internalizing problems (e.g., depression symptoms) in adolescents during the COVID-19 pandemic and specifically during a school lockdown (Bernasco et al., 2021; Houghton et al., 2022). However, these previous studies comparing pre- and during-COVID-19 pandemic measures only incorporated one or two data collection points at the start of the COVID-19 pandemic in 2020, and whether these effects remained similar or became amplified across the course of the pandemic is not yet known.

Current Study

To obtain a better understanding of the impact of the COVID-19 pandemic on adolescents' mental and academic well-being, the aim of the current study was to examine possible changes in the academic achievement and internalizing problems of young adolescents (aged 11-16) across two full academic years during the COVID-19 pandemic (November 2019 until June 2021). Specifically, we examined whether friendship quality buffered against changes in the academic achievement and changes in internalizing problems of young adolescents during the COVID-19 pandemic. Our longitudinal study comprised four data collection points across two academic years, with timepoint 1 (T1) (pre-pandemic: November 2019) and T2 (beginning pandemic: May/June 2020) in the first academic year, and T3 (November/December 2020) and T4 (May/June 2021) in the second academic year. We preregistered this study on the open science framework (OSF) before we conducted the analyses, and we also uploaded our deviations from the preregistration on OSF (see https://osf.io/z3cyh/?view_only=11ff1226d7e24bd8aafe82ede0b3bdb0).

Based on previous research, we hypothesized that the COVID-19 pandemic would have a negative effect on academic achievement (Hypothesis 1a; Li et al., 2021; Panagouli et al., 2021), as measured with objective school records. We expected the change in academic achievement to be most pronounced at the beginning of the pandemic (T2) compared to before the pandemic (T1). Furthermore, we hypothesized that better friendship quality (i.e., high positive and low negative friendship quality) would have a buffering effect on the changes in academic achievement across the COVID-19 pandemic (Hypothesis 1b; Broadbent & Poon, 2015). That is, we expected that friendship quality would moderate the influence of time on academic achievement. Specifically, we expected that for adolescents with a better friendship quality (i.e., high positive and low negative friendship quality) academic achievement would not change over time (across the pandemic), whereas for adolescents with a lower friendship quality academic achievement would decrease over time (across the pandemic).

Our second hypothesis was that there would be an increase in internalizing problems over time during the COVID-19 pandemic (Hypothesis 2a; Ellis et al., 2020; Li et al., 2021; Weissman et al., 2021). We expected this change in internalizing problems to be most pronounced from T1 to T4, because we expected a cumulative negative effect of the restrictions of the pandemic on adolescents' internalizing problems. Finally, we hypothesized that better friendship quality (i.e., high positive and low negative friendship quality) would have a buffering effect on the changes in internalizing problems across the COVID-19 pandemic (Hypothesis 2b; Bernasco et al., 2021; Houghton et al., 2022). That is, we expected that friendship quality would moderate the influence of time on internalizing problems. Specifically, we expected that for adolescents with a better friendship quality (i.e., high positive and low negative friendship quality) internalizing problems would not

change over time (across the pandemic), whereas for adolescents with a lower friendship quality internalizing problems would increase over time (across the pandemic).

2. METHODS

2.1. Participants

This prospective longitudinal study comprised two years of data collection across four data collection points including participants from one local Dutch high school. See Table 1 for the demographic characteristics of our study sample. Our study sample consisted of 250 adolescents at timepoint 1 (T1, age range = 11 - 15), 161 adolescents at T2 (age range = 11 - 15), 119 adolescents at T3 (age range = 12 - 16), and 107 adolescents at T4 (age range = 13 - 16). The participants were attending the 1st, 2nd or 3rd grade of senior general secondary education (HAVO) or pre-university education (VWO) (see Table 1 for details). Of the 250 adolescents at T1, 241 adolescents (96.4%) were born in the Netherlands, 5 participants were born in another European country (Germany, England, France, Russia) and 3 participants were born in a non-European country (China, the Philippines, Peru). The highest level of completed education of parents was obtained in the first year of data collection from 161 participants, which indicated that more than half of the sample had at least one parent with high professional education (HBO; 38.5% first parent, 27.3% second parent) or university education (WO; 19.9% first parent, 6.8% second parent). See the Supplement for a complete break-down of educational level.

Table 1 Demographic characteristics of sample per timepoint.

Variable	T1	T2	T3	T4
N	250	161	119	107
M age	13.04	13.54	14.06	14.60
SD age	0.67	0.65	0.66	0.68
Range age	11.46 - 15.12	11.97 - 15.60	12.47 - 16.05	13.02 - 16.55
Gender identity (N (%))				
Boy	119 (47.8%)	76 (47.2%)	51 (42.9%)	40 (37.4%)
Girl	125 (50.2%)	80 (49.7%)	66 (55.5%)	64 (59.8%)
Both a boy and a girl	3 (1.2%)	1 (0.06%)	1 (0.08%)	0
I don't know (yet)	1 (0.4%)	3 (1.9%)	1 (0.08%)	3 (2.8%)
Educational level				
1st grade HAVO/VWO (%)	25.6	21.8		
1st grade VWO (%)	22.4	24.8		
2nd grade HAVO (%)	21.2	22.3	12.6	13.1
2nd grade VWO (%)	30.8	31.1	31.1	29.9
3rd grade HAVO (%)			23.5	26.1
3rd grade VWO (%)			32.8	30.8

2.2. Procedure

This study was originally part of a bigger research project on the longitudinal changes in friendship quality and peer relationships in early adolescence, which we adapted to an online format after T1 due to the COVID-19 pandemic. The data collection of T1 took place in November 2019 (before the COVID-19 pandemic) to allow time for the participants to get acquainted with their classmates in the new academic year. The second data collection point (T2) took place before the summer break in May-June 2020, the third data collection point (T3) at the start of the next academic year 2020-2021, in November-December 2020, and the fourth data collection point (T4) was before the summer break in May-June 2021. See Figure 1 for an overview of the Dutch COVID-19 measures which were most relevant during this study. The data collection of T2 (in May-June 2020) mostly took place during the first school lockdown and on 2 June 2020 high schools partially opened. The data collection of T3 (in November-December 2020) took place while high schools were fully open and was completed in the beginning of December 2020 before high schools closed again, but there was a partial lockdown with social and societal restrictions (e.g., receiving a maximum of two visitors at home). The data collection of T4 (in May-June 2021) mostly took place while high schools were partially open, on 31 May 2021 high schools fully opened and in May/June 2021 social and societal restrictions were also relaxed (e.g., receiving more visitors at home).

The participants were recruited by contacting a local Dutch high school. After the school board agreed to participate, the parents were informed during a parent meeting and were asked to sign informed consent. All participants and their parents/caregivers signed informed consent before the start of this study. The data collection at T1 was at the school and spread across 2 sessions of 50 minutes, one-to-two weeks apart. In those two sessions the participants completed online questionnaires and an experimental task (that will be reported elsewhere) on computers or laptops of the school via Qualtrics. During both sessions two or three researchers were present at school to explain the session to the participants and answer questions from the participants. Due to the pandemic, data collection at T2, T3, and T4 was online where the participants filled out questionnaires at home via Qualtrics.

During T1 each participating high school class received a gift card of 50 Euros. In addition, there was a lottery through which one student of each class could win a gift card of 5 Euros. During both T2 and T3 the participants received 5 Euros for completing the online questionnaires; during T4 this compensation was 7.50 Euros. At the end of T4 all classes that participated in the study received an additional gift card of 60 Euros, which they could spend as a class together with their mentor. The study was approved by the local institutional ethics committee.

2.3. Materials

2.3.1. Friendship Quality

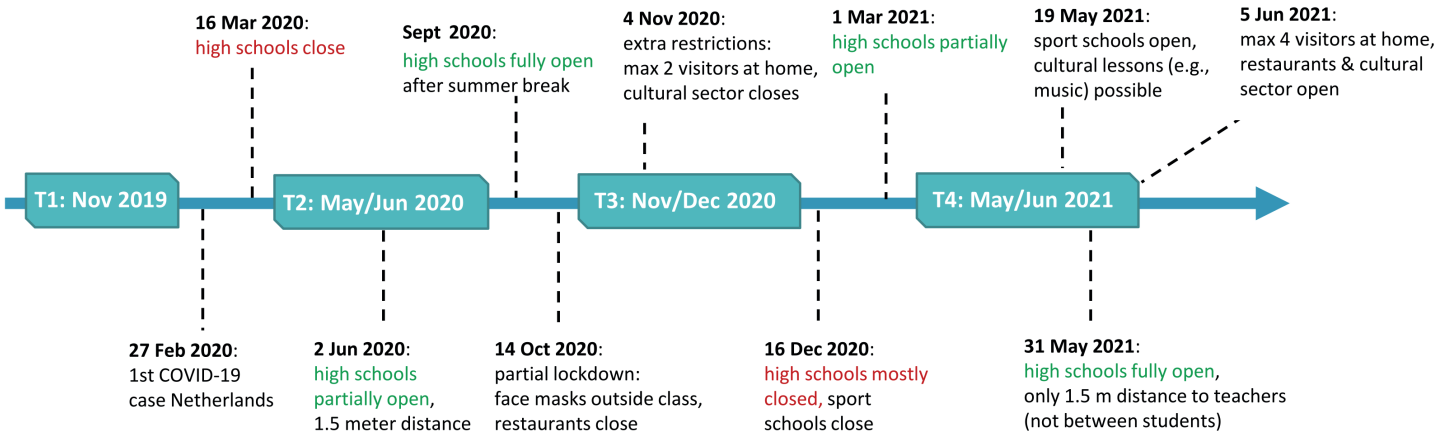
Positive friendship quality was measured with three items from the Friendship Quality Scale (FQS; Bukowski et al., 1994). The original FQS is divided into five subscales. The current study used three positive items from the security subscale (e.g., "If my friend or I do something that bothers the other one of us, we can make up easily"). The questions were answered on a 5-point scale ranging from 1 (*probably not true*) to 5 (*really true*). The participants filled out the three positive friendship quality items for each of their top three friends in the classroom, so in total these nine items were averaged for positive friendship quality. The internal consistency of the positive friendship quality scale in our study was good across all data collection points (range Cronbach's α = .82 - .87).

Negative friendship quality was measured with three items from the Network of Relationship Inventory - Relationship Qualities Version (NRI-RQV; Buhrmester & Furman, 2008). The original NRI-RQV consists of ten subscales. The current study used three negative items from the conflict subscale (e.g., "How often do you and this friend disagree and quarrel with each other?"), except at T1, where only two items of this subscale were administered. To deal with this discrepancy we compared results between the models (see Analysis plan below) with only two negative friendship quality (FQ) items and models with three negative FQ items. The conclusions of these analyses were the same, so we continued the subsequent analyses with the three negative FQ items per friend for T2-T4. The items were answered on a 5-point scale ranging from 1 (*never*) to 5 (*always*). The participants filled out the negative friendship quality items also for each of their top three friends in the classroom, and we averaged the scale score across these three friends. The internal consistency of the negative friendship quality scale in our study was good across all data collection points (range Cronbach's α = .81 - .83).

2.3.2. Academic Achievement

To measure academic achievement, we obtained school records for fall and spring report grades of the participants on the subjects Dutch, English, and Math. These subjects were mandatory for students of all educational levels, and thus for all participants in our sample. Research has shown that these subjects are valid measures of academic achievement (Reed et al., 2010). The grades in the Dutch educational system range from 1 to 10, whereby at least a 5.5 is needed to pass a subject. The academic achievement scale score consists of the mean of the three grades.

Figure 1. Timeline Dutch COVID-19 measures during the current study.



Note. The T3 data collection was completed in the beginning of December 2020 before the high schools closed again. At all times students of parents with crucial professions and students with special needs were able to go to school, also during the lockdowns. At T4 only 1 participant indicated that this participant went to school 4 days a week during the first lockdown (halfway March until end May 2020) and 5 days a week during the second lockdown (halfway December 2020 until end February 2021) due to the crucial profession of the parent(s).

2.3.3. Internalizing Problems

Internalizing problems were measured with the emotional symptoms subscale of the Strengths and Difficulties Questionnaire (SDQ; Van Widenfelt et al., 2003). The original SDQ consists of five subscales and 25 items in total. For this study, the five items of the emotional symptoms subscale were used (e.g., "I am often unhappy, downhearted or tearful"), which were answered on a 3-point scale ranging from *not true* to *certainly true*. The internalizing problems scale score consists of the mean of the five items. The internal consistency of the internalizing problems scale in our study was acceptable across all data collection points (range Cronbach's α = .72 - .77).

2.3.4. Covariates

Gender Identity. At each timepoint gender was measured with one item on gender identity. The participants were asked: "What gender are you according to your feelings? This does not have to be the same as your gender assigned at birth." There were five answer options: a boy; a girl; both a boy and a girl; not a boy and also not a girl (neither); I don't know (yet). In our analyses we included the two most common answer options for this variable: identify as a boy; identify as a girl. The other less common answer options were coded as missing values. These less common answer options (e.g., identify as both a boy and a girl; do not know (yet) what gender they identified with) occurred in 1.7 - 3.1% of the participants across all data collection points. This variable was coded using a sum-to-zero contrast.

Time Spent with Peers. Face-to-face time spent with peers was measured with one item at all four data collection points. The participants were asked on average how many times a week they met with their peers outside of school-time. The item was answered on a scale ranging from 0 (*not at all*) to 7 (*seven days a week*).

2.4. Analysis Plan

For all our analyses, we conducted linear mixed models (LMMs) using the lme4 package in R version 4.1.3 (Bates et al., 2007) and R studio version 1.4.1717. We report all results at α = 0.05; for our two models (model on academic achievement and model on internalizing problems) we additionally indicate which results survive a Bonferroni correction to control for multiple comparisons (α = 0.05/2 = 0.025). We winsorized all significant outliers (z-values > |3.29|) in our dependent and independent study variables. Analyses on possible changes in friendship quality over time are reported in the Supplements.

The response rates were lower at T2-T4 than at T1 because our data collection took place at the high school at T1, but we had to continue our data collection at T2-T4 in an online format due to the COVID-19 pandemic. Linear mixed-effects models have the advantage to handle longitudinal data and missing datapoints. That said, we checked whether participants who dropped-out of our study after T1 differed in academic achievement,

internalizing problems, positive and negative friendship quality, and demographic variables (age, gender identity, education level, and country of birth) compared to participants who participated in at least one additional data collection point besides T1. We did not find any significant differences (see sensitivity analyses on missing data in Supplements).

2.4.1. Analyses Friendship Quality and Academic Achievement/Internalizing Problems

We examined the effect of timepoint, friendship quality, and the interaction effects between friendship quality and timepoint on adolescents' academic achievement and internalizing problems during the COVID-19 pandemic. To test our hypotheses on academic achievement, we conducted a LMM with academic achievement as dependent variable, using a hierarchical step-by-step procedure (see Table 2). Here we compared a null model with a model including main effects of timepoint (linear), positive friendship quality and negative friendship quality, and with a model including positive friendship quality × timepoint (linear) and negative friendship quality × timepoint (linear) interaction terms. We additionally tested if adding timepoint (quadratic, cubic) and positive friendship quality x timepoint (quadratic, cubic) and negative friendship quality × timepoint (quadratic, cubic) interaction terms improved model fit. Models were compared using AIC and BIC values. When two models showed a similar fit, we chose the simpler model of the two for parsimony. In all models, gender and time spent with peers were included as covariates. Although not preregistered (see published deviations from preregistration: https://osf.io/z3cyh/?view_only=11ff1226d7e24bd8aafe82ede0b3bdb0), in the case of significant timepoint effects, we further examined between which specific timepoints academic achievement changed, by additionally testing a model (post-hoc) in which timepoint was included as a factor instead of a continuous measure. This allowed to directly compare different timepoints to each other. For our hypotheses on internalizing problems, we used the exact same model-building procedure as described for academic achievement (see Table 2).

Table 2. Overview of linear mixed effects model-building procedure.

Academic Achievement (AA)
AA ~ 1 + 1 | Subject
AA ~ Gender + Time spent with peers + Timepoint(linear) + NegFQ + PosFQ + 1 | Subject
AA ~ Gender + Time spent with peers + Timepoint(linear) × NegFQ + Timepoint(linear) × PosFQ + 1 | Subject
AA ~ Gender + Time spent with peers + Timepoint(quadratic) × NegFQ + Timepoint(quadratic) × PosFQ + 1 | Subject
AA ~ Gender + Time spent with peers + Timepoint(cubic) × NegFQ + Timepoint(cubic) × PosFQ + 1 | Subject
Internalizing Problems (IP)
IP ~ 1 + 1 | Subject
IP ~ Gender + Time spent with peers + Timepoint(linear) + NegFQ + PosFQ + 1 | Subject
IP ~ Gender + Time spent with peers + Timepoint(linear) × NegFQ + Timepoint(linear) × PosFQ + 1 | Subject
IP ~ Gender + Time spent with peers + Timepoint(quadratic) × NegFQ + Timepoint(quadratic) × PosFQ + 1 | Subject
IP ~ Gender + Time spent with peers + Timepoint(cubic) × NegFQ + Timepoint(cubic) × PosFQ + 1 | Subject

Note. NegFQ = Negative Friendship Quality. PosFQ = Positive Friendship Quality. In case of significant timepoint effects, we additionally tested a model (post-hoc) with timepoint as factor to directly compare different timepoints on academic achievement (AA ~ Gender + Time spent with peers + Timepoint(factor) + NegFQ + PosFQ + 1 | Subject) and on internalizing problems (IP ~ Gender + Time spent with peers + Timepoint(factor) + NegFQ + PosFQ + 1 | Subject). Polynomials include all lower-order terms as well (e.g., Timepoint(cubic) = Timepoint(linear) + Timepoint(quadratic) + Timepoint(cubic)). Interaction effects presented include main effects as well (e.g., Timepoint(cubic) × NegFQ = Timepoint(linear) + Timepoint(quadratic) + Timepoint(cubic) + NegFQ + Timepoint(linear) × NegFQ + Timepoint(quadratic) × NegFQ + Timepoint(cubic) × NegFQ).

3. RESULTS

3.1. Friendship Quality and Academic Achievement

The parameter estimates for the best fitting mixed models are shown in Table 3. First, we examined the effect of adolescents' friendship quality (FQ) on their academic achievement over time. The best model that described academic achievement was a model including main effects of timepoint (linear), negative FQ, positive FQ, and the covariates gender and time spent with peers. This indicates that in contrast to our hypotheses, interactions between timepoint and negative/positive FQ were not significant (all *p*s > .17). Thus, we did not find a buffering effect of friendship quality on academic achievement specifically during the pandemic. In our best fitting model, we found that girls (*EMM* = 6.83, *SE* = 0.09) had a higher academic achievement than boys (*EMM* = 6.37, *SE* = 0.10, *b* = -0.23, *SE* = 0.07, *p* < .001). There were no significant main effects of negative FQ, positive FQ and time spent with peers on academic achievement (all *p*s > .67). Across timepoints, there was a linear decrease in academic achievement (*b* = -5.48, *SE* = 1.17, *p* < .001; see Figure 2A).

To further examine between which timepoints academic achievement changed, we included timepoint as factor (instead of timepoint linear) in the previous best fitting model and performed a post-hoc test to examine which timepoints differed significantly from each other. Our results showed that academic achievement was higher at T1 (*EMM*

= 6.73, *SE* = 0.09) compared to T3 (*EMM* = 6.27, *SE* = 0.11, *p* = .002) and T4 (*EMM* = 6.27, *SE* = 0.11, *p* = .004), and higher at T2 (*EMM* = 6.88, *SE* = 0.09) compared to T3 (*p* < .001) and T4 (*p* < .001). That is, adolescents' academic achievement significantly decreased at T3 (see Figure 2B). There was no significant difference in academic achievement between T1 and T2 (*p* = .52) and between T3 and T4 (*p* = 1.00).

3.2. Friendship Quality and Internalizing Problems

Next, we examined the effect of adolescents' friendship quality on their internalizing problems over time. The best model that described internalizing problems was a model including main effects of timepoint (linear), negative FQ, positive FQ, and the covariates gender and time spent with peers. This indicates that in contrast to our hypotheses, interactions between timepoint and negative/positive FQ were not significant (all *p*s > .15). Thus, we did not find a buffering effect of friendship quality on internalizing problems specifically during the pandemic. In our best fitting model, girls (*EMM* = 1.72, *SE* = 0.04) reported more internalizing problems than boys (*EMM* = 1.41, *SE* = 0.04, *b* = -0.16, *SE* = 0.03, *p* < .001). Adolescents with higher negative friendship quality had more internalizing problems (*b* = 0.10, *SE* = 0.04, *p* = .014; see Figure 2C), and adolescents with higher positive friendship quality had fewer internalizing problems (*b* = -0.07, *SE* = 0.03, *p* = .009; see Figure 2D). There was no significant effect of time spent with peers on internalizing problems (*p* = .93). Across timepoints, there was a linear increase in internalizing problems (*b* = 1.50, *SE* = 0.36, *p* < .001; see Figure 2E).

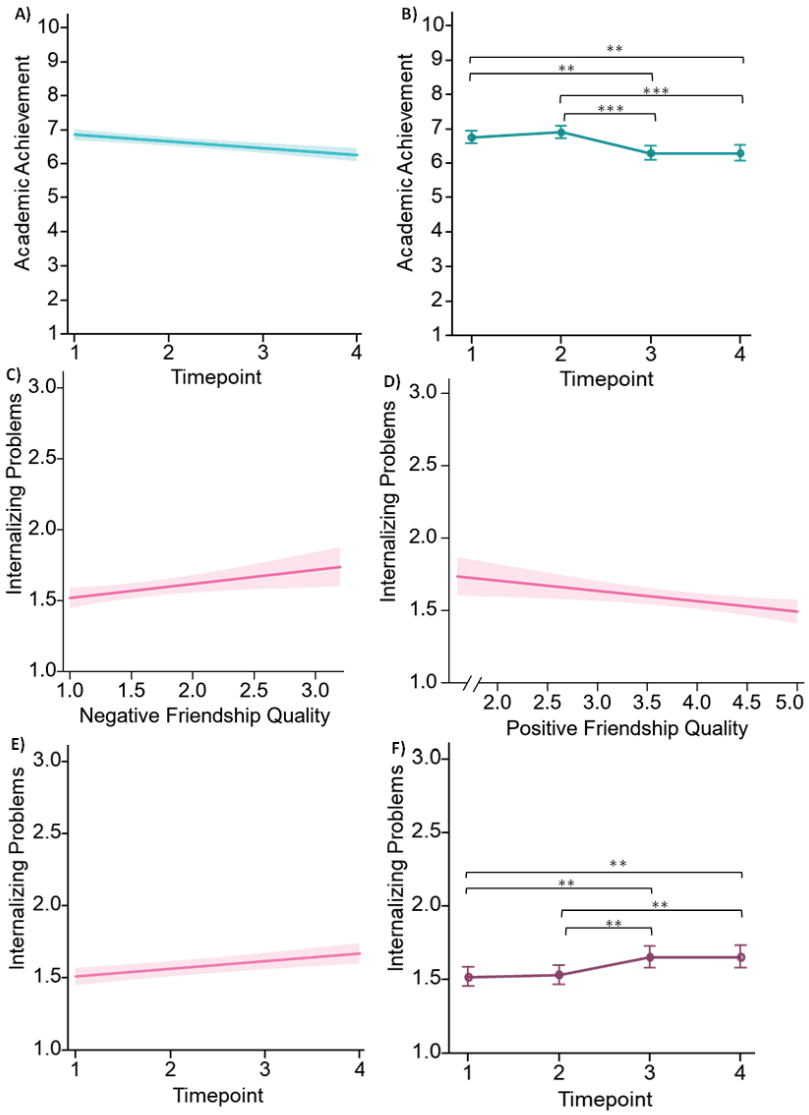
To further examine between which timepoints internalizing problems changed, we included timepoint as factor (instead of timepoint linear) in the previous best fitting model and performed a post-hoc test to examine which timepoints differed significantly from each other. Our results showed that internalizing problems were higher at T3 (*EMM* = 1.64, *SE* = 0.04) compared to T1 (*EMM* = 1.51, *SE* = 0.03, *p* = .003) and T2 (*EMM* = 1.52, *SE* = 0.03, *p* =.005), and higher at T4 (*EMM* = 1.64, *SE* = 0.04) compared to T1 (*p* = .006) and T2 (*p* = .009). That is, adolescents' internalizing problems significantly increased at T3 (see Figure 2F). There was no significant difference in internalizing problems between T1 and T2 (*p* = .98) and between T3 and T4 (*p* = 1.00).

Table 3. Statistical parameters for the best fitting mixed models.

Dependent variable	Fixed effects	*b*	*SE*	*p*
Academic achievement	Intercept	6.79	0.42	< .001*
	Gender	-0.23	0.07	< .001*
	Time spent with peers	-0.02	0.05	.72
	Timepoint (linear)	-5.48	1.17	< .001*
	Negative FQ	-0.05	0.12	.67
	Positive FQ	-0.03	0.08	.75
Internalizing problems	Intercept	1.67	0.14	< .001*
	Gender	-0.16	0.03	< .001*
	Time spent with peers	0.002	0.02	.93
	Timepoint (linear)	1.50	0.36	< .001*
	Negative FQ	0.10	0.04	.014*
	Positive FQ	-0.07	0.03	.009*

Note. *Significant after Bonferroni correction for multiple comparisons ($\alpha = 0.05/2 = 0.025$).

Figure 2. Results of the best fitting mixed models, showing the effects of (a) Timepoint (linear) on Academic Achievement, (b) Timepoint (factor) on Academic Achievement, (c) Negative Friendship Quality (FQ) on Internalizing Problems, (d) Positive FQ on Internalizing Problems, (e) Timepoint (linear) on Internalizing Problems, and (f) Timepoint (factor) on Internalizing Problems. ** p < .01, *** p < .001



4. DISCUSSION

In this study, we investigated the possible changes in academic achievement, and internalizing problems of young adolescents (aged 11-16) across two full academic years during the COVID-19 pandemic (November 2019 until June 2021). Specifically, we examined whether friendship quality buffers against changes in the academic achievement and internalizing problems of young adolescents during the COVID-19 pandemic. In line with our hypotheses, our results showed that academic achievement decreased over time, and internalizing problems increased over time across two years during the COVID-19 pandemic. Contrary to our expectations, we did not find evidence for a buffering effect of friendship quality during the COVID-19 pandemic. However, our results provided support for the significance of friendship quality by showing that across all timepoints adolescents with higher negative friendship quality had more internalizing problems, whereas adolescents with higher positive friendship quality had fewer internalizing problems.

4.1. Changes in Academic Achievement across the Pandemic

Our findings demonstrated that there was a linear decrease in adolescents' academic achievement over time. Specifically, we found that academic achievement was higher in the first academic year (T1 and T2) than the second academic year (T3 and T4). Our results mostly support our hypothesis, as we expected that the COVID-19 pandemic would have a negative effect on adolescents' academic achievement, but we expected this change in academic achievement to be most pronounced from T1 (pre-pandemic) to T2 (start of the pandemic). In the second year of the study the adolescents experienced the restrictions of the pandemic for a longer time, including the possible negative effect of online education on their academic achievement. Our findings are in line with a systematic review in children and adolescents that has shown that students experienced learning losses during the pandemic compared to pre-pandemic years (Panagouli et al., 2021). Furthermore, a report on grades of Dutch high school students has demonstrated that grades are more stable in the years before the pandemic (2016/2017 and 2018/2019) compared to the first year of the pandemic (2020/2021) in which a decrease was found in the grades Dutch and Math (Zijlstra et al., 2021). This suggests that the decrease in academic achievement that we found is likely to be specific to the pandemic and not a general decrease in academic achievement across high school years. Tentatively, lower motivation could possibly play a role in the decreased academic achievement of adolescents during the pandemic. A recent study has indeed shown that adolescents' academic motivation was lower on online compared to physical school days (Klootwijk et al., 2021), and motivation has been shown to affect academic achievement (Kriegbaum et al., 2018). Our study did not examine academic motivation and future studies could disentangle the effects of a pandemic or another crisis on adolescents' academic motivation and achievement. In addition, we found that girls had

a higher academic achievement than boys, which is in line with previous literature (e.g., Marcenaro–Gutierrez et al., 2018).

In contrast to our hypothesis, we did not find a significant effect of adolescents' positive and negative friendship quality on (changes in) their academic achievement across the pandemic. Interestingly, a recent study has demonstrated that adolescents with increasing academic well-being during the pandemic also showed an increase in social engagement (Salmela-Aro et al., 2021). However, this prior study more generally examined positive relationships with other people, and not specifically with (high-quality) friends. In addition, the prior study examined academic well-being by measuring school engagement and burnout, instead of academic achievement. A possible explanation for the fact that we did not find a buffering effect of friendship quality on academic achievement during the pandemic could be related to the online education, where friends could have had less opportunities to study together and motivate one another. We found that adolescents' academic achievement decreased over time, but positive friendship quality remained stable (see Supplements). Despite this stability in positive friendship quality, it was not enough to buffer the decrease in adolescents' academic achievement. Even though adolescents were still able to maintain their positive friendship quality (maybe also through online contact with friends), the lack of opportunities to study together with their friends on school during the pandemic might have influenced possible buffering effects of friendship quality on academic achievement. Previous meta-analyses have indeed shown that learning from peers in a school setting (i.e., peer tutoring) has a positive effect on the academic achievement of students (Leung, 2015, 2019). Due to the social contact-restrictions and school lockdowns during the pandemic, parents could possibly have played a more important role than peers for influencing academic achievement. A daily diary study during the COVID-19 pandemic has indeed shown that support from parents, but not from friends, buffered decreases in adolescents' academic motivation during online school days (Klootwijk et al., 2021). Future research needs to be done to reveal whether parental support also buffers decreases in adolescents' academic achievement during the pandemic or another crisis. Thus, more research is needed to disentangle the relationship between adolescents' friendship (quality), parental support, academic motivation, and academic achievement during a crisis, such as the pandemic.

4.2. Effect of Time and Friendship Quality on Internalizing Problems

Next, we found that internalizing problems increased over time. Our findings mostly support our hypothesis, as we expected that there would be an increase in internalizing problems over time during the COVID-19 pandemic. However, we expected this change in internalizing problems to be most pronounced when comparing T1 to T4, as we expected a cumulative negative effect of the pandemic's restrictions on internalizing problems. Our results indicated that adolescents experienced more internalizing problems in the

second academic year of the study (T3-T4, 2020-2021) than in the first academic year of the study (T1-T2, 2019-2020). In the second year of the study the adolescents experienced the social and societal restrictions of the pandemic for a longer time, including the possible negative impact of the social-distancing measures, lockdowns, and social isolation on the development of internalizing problems. Speculatively, internalizing problems did not increase further from T3 to T4, because society was opening again as adolescents were for example able to receive more visitors at home and perform their hobby's outside of home (see Figure 1). Prior research has shown that adolescents experienced more internalizing problems in the first year (2020) of the COVID-19 pandemic (Ellis et al., 2020; Li et al., 2021; Weissman et al., 2021). In line with our findings, a meta-analysis has demonstrated that the prevalence of depression and anxiety symptoms in children and adolescents was higher in studies collected later in the first year (2020) of the COVID-19 pandemic compared to studies collected earlier in the pandemic (Racine et al., 2021). Our findings extend these previous findings by demonstrating an increase in adolescents' internalizing problems across a more extensive period of two years during the COVID-19 pandemic. Specifically, our results showed higher internalizing problems later in the pandemic (November/December 2020, May/June 2021) compared to before the pandemic (November 2019) and the beginning of the pandemic (May/June 2020). Furthermore, prior research on internalizing problems has shown that anxiety symptoms (slightly) decreased and depressive symptoms were stable during early adolescence (ages 10-15) (Hale et al., 2008; McLaughlin & King, 2015; Van Oort et al., 2009). This suggests that the increase in internalizing problems that we found in early adolescence is likely to be specific to the pandemic and not a general age-related increase in internalizing problems. In addition, we found that girls had more internalizing problems than boys, which was consistent with previous research findings in many countries across the world (Rescorla et al., 2012).

Our results do not provide support for our hypothesis that better friendship quality (i.e., high positive and low negative friendship quality) has a buffering effect on the changes in internalizing problems across the COVID-19 pandemic, as we did not find any significant interaction effects between positive or negative friendship quality and timepoint on internalizing problems. However, we found that adolescents with higher negative friendship quality had more internalizing problems, whereas adolescents with higher positive friendship quality had fewer internalizing problems. In other words, we found that across all timepoints adolescents with better friendship quality (i.e., high positive and low negative friendship quality) reported fewer internalizing problems, supporting the significance of friendship quality for mental health outcomes. Our findings could be interpreted to suggest that adolescents with better quality friendships could develop fewer internalizing problems. However, given that our analyses were correlational and not causal, it is also possible that adolescents with fewer internalizing problems are more likely to form, maintain or perceive themselves to have better quality friendships. In accordance

with our findings, two prior studies demonstrated that higher pre-COVID-19 pandemic friendship quality was related to fewer internalizing problems in young adolescents during the COVID-19 pandemic and specifically during a school lockdown (Bernasco et al., 2021; Houghton et al., 2022). Our findings replicate and extend these prior results (which were based on data collection points in the beginning of the pandemic in 2020) by showing a significant relationship between friendship quality and internalizing problems across a more extensive period of two years during the COVID-19 pandemic. Furthermore, our results highlight the importance for adolescents to not only maintain positive friendship quality with their friends, but to also reduce negative friendship quality (e.g., conflicts with friends), as both higher positive and lower negative friendship quality are related to fewer internalizing problems.

We did not find a significant effect of time spent with peers on internalizing problems. Our findings are in in line with a previous study in adolescents that did not find an effect of time spent with friends on internalizing problems during the COVID-19 pandemic, whereas pre-pandemic friendship quality was related to fewer internalizing problems during the pandemic (Bernasco et al., 2021). Our results reveal that the quality of interactions with friends, but not the quantity (i.e., time spent with peers) is significantly related to adolescents' mental health (i.e., fewer internalizing problems). Frequent interactions with friends could possibly not only entail positive interactions (e.g., support), but also negative interactions (e.g., conflict). Speculatively, our finding suggests that it might be especially important for the mental health of adolescents (i.e., develop fewer internalizing problems) to maintain the quality of their friendships, more so than the interaction frequency (i.e., quantity). However, our findings are correlational and future studies are needed to further examine the causal relationship between friendship quality, time spent with friends, and internalizing problems across a crisis, such as the pandemic.

4.3. Limitations, Strengths, and Future Directions

Our current study has a few limitations. Our participants and their parents were relatively highly educated. A recent study has found that during the pandemic students of parents with a low education learned less than students of highly educated parents (Haelermans et al., 2022). Thus, future studies should aim for a more diverse sample. In addition, future research should aim to collect more detailed information on daily experiences to examine the possible causal protective effect of adolescents' friendship quality on their internalizing problems during the pandemic, for example with a daily diary method or frequent ecological momentary assessments (EMAs) sampling. Future studies should also include friendship stability as it has been shown to influence positive friendship quality (Bernasco et al., 2021; Schreuders et al., 2021).

However, a strength of our current study is the longitudinal design across a long study period of two academic years, including four data collection points. Furthermore, our

longitudinal study included a baseline before the pandemic (T1) and three data collection points across differential timepoints during the pandemic (T2, T3, and T4). This allowed us to examine whether the effects were specific to the pandemic and to which period during the pandemic. Moreover, we examined both positive and negative friendship quality, which allowed us to distinguish the differential relationships between adolescents' positive friendship quality versus negative friendship quality and internalizing problems.

4.4. Conclusion

In conclusion, our findings demonstrated that adolescents' academic achievement decreased over time, and internalizing problems increased over time across two years during the COVID-19 pandemic. Future government policies on lockdowns and restrictions during the pandemic or another crisis should consider such adverse effects of the pandemic on adolescents' academic achievement and internalizing problems. Furthermore, we found that across all timepoints adolescents with higher negative friendship quality had more internalizing problems, whereas adolescents with higher positive friendship quality had fewer internalizing problems. This finding supports prior evidence on the significance of friendships for adolescent well-being and mental health (Güroğlu, 2022). Future research should aim to further examine causal relationships and to reach stronger conclusions regarding the possible protective effects of adolescents' friendship quality on developmental outcomes, particularly during a crisis, such as the pandemic.

SUPPLEMENTARY MATERIALS

Education parents

The highest level of completed education of the first parent out of the 161 adolescents at T2 was for 6.8% pre-vocational secondary education (VMBO), 5.6% senior general secondary education (HAVO), 6.2% pre-university education (VWO), 22.3% secondary vocational education (MBO), 38.5% high professional education (HBO), and 19.9% university education (WO). The highest level of completed education of the second parent out of the 161 adolescents at T2 was for 0.6% primary education, 13.7% VMBO, 5.6% HAVO, 3.1% VWO, 39.1% MBO, 27.3% HBO, and 6.8% WO.

Outliers

We detected two significant outliers (z-values > |3.29|) in mean positive friendship quality (FQ), and one significant outlier in mean negative FQ. All significant outliers (z-values > |3.29|) were winsorized.

Sensitivity Analyses on Missing Data

Of all 250 participants at T1, 81 adolescents only completed the online questionnaires at T1, and 169 adolescents participated in at least one additional data collection point at T2, T3 and/or T4. We performed five separate Welch two sample t-tests to examine whether age, positive friendship quality (FQ), negative FQ, academic achievement and internalizing problems at T1 differed between adolescents who only participated in T1 and adolescents who participated in at least one additional data collection point besides T1. The results showed that adolescents who only participated in T1 and adolescents who participant in at least one additional data collection point did not differ in age, positive FQ, negative FQ, and academic achievement at T1 (all ts < 0.83; all ps > .41). Internalizing problems at T1 were lower in adolescents who only participated in T1 (M = 1.41) compared to adolescents who participated in at least one additional data collection point (M = 1.55), t(144.73) = 2.11, p = .04, but this difference did not survive a Bonferroni correction to control for multiple comparisons (α = 0.01, number of tests = 5).

Additionally, we performed three separate chi-square tests to examine whether the demographic characteristics gender identity, educational level, and country of birth at T1 differed between adolescents who only participated in T1 and adolescents who participated in at least one additional data collection point besides T1. We included two categories of education level in the analysis: classes of pre-university education (VWO) and classes of senior general secondary education (HAVO, for the first-grade classes mixed with VWO). For the participants' country of birth, we included two categories: the Netherlands and another country than the Netherlands. The results showed that adolescents who only participated in T1 and adolescents who participated in at least one additional data

collection point did not differ in gender identity, educational level, and country of birth (all χ^2s < 1.91; all *p*s > .16).

Analyses Friendship Quality over Time

To test our hypotheses on friendship quality, we conducted linear mixed models (LMMs) using a step-by-step model-building procedure (see Table S1 for an overview of the models). Specifically, we first fitted a "null model" with friendship quality as dependent variable, including a fixed intercept and a random intercept per participant only. Next, we added gender, timepoint (linear), and a gender × timepoint (linear) interaction effect. Finally, we added timepoint (quadratic, cubic) and gender × timepoint (quadratic, cubic) interaction effects. After selecting the best-fitting gender/time model (based on AIC, BIC values), we added time spent with peers as additional covariate and tested whether this improved model fit. These analyses were conducted separately for positive and negative friendship quality as dependent variables. For these two friendship quality models we indicate which results survive a Bonferroni correction to control for multiple comparisons (α = 0.05/2 = 0.025).

Table S1. Overview of linear mixed effects model-building procedure for friendship quality.

Friendship Quality (FQ)
FQ ~ 1 + 1 | Subject
FQ ~ Gender + 1 | Subject
FQ ~ Gender + Timepoint(linear) + 1 | Subject
FQ ~ Gender × Timepoint(linear) + 1 | Subject
FQ ~ Gender × Timepoint(quadratic) + 1 | Subject
FQ ~ Gender × Timepoint(cubic) + 1 | Subject
FQ ~ [best gender/time model] + Time spent with peers + 1 | Subject

Note. Models were run separately for positive and negative FQ. Polynomials include all lower-order terms as well (e.g., Timepoint(cubic) = Timepoint(linear) + Timepoint(quadratic) + Timepoint(cubic)). Interaction effects presented include main effects as well.

Friendship Quality over Time

The parameter estimates for the best fitting mixed models of friendship quality are shown in Table S2. The best-fitting gender/time model that described negative friendship quality was a model including a main effect of gender and a main effect of timepoint (linear). We next tested whether adding time spent with peers as a covariate improved model fit above this best gender/time model, and this was the case. Time spent with peers was positively associated with negative friendship quality (*b* = 0.04, *SE* = 0.02, *p* = .04), but this relation was not significant after a Bonferroni correction to control for multiple comparisons (α = 0.025). Across timepoints, there was a linear decrease in negative friendship quality (*b* = -1.98, *SE* = 0.41, *p* < .001; see Figure S1A). To further examine between which timepoints negative friendship quality changed, we included timepoint as factor (instead of timepoint linear) in the previous model and performed a post-hoc test to examine which timepoints

differed significantly from each other. Our results showed that negative friendship quality was higher at T1 (*EMM* = 1.72, *SE* = 0.03) compared to T2 (*EMM* = 1.58, *SE* = 0.04, *p* = .003), T3 (*EMM* = 1.57, *SE* = 0.04, *p* = .007) and compared to T4 (*EMM* = 1.49, *SE* = 0.04, *p* < .001), and negative friendship quality did not differ between the other timepoints (all *p*s > .19).

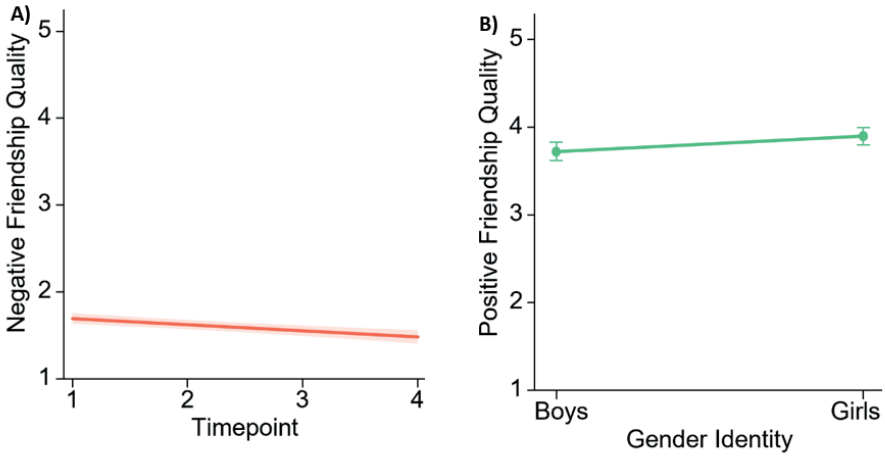
The best-fitting gender/time model that described positive friendship quality was a model including only a main effect of gender. Girls (*EMM* = 3.90, *SE* = 0.05) reported a higher positive friendship quality than boys (*EMM* = 3.72, *SE* = 0.05, *b* = -0.09, *SE* = 0.04, *p* = .02; see Figure S1B).

Table S2. Statistical parameters for the best fitting mixed models of friendship quality.

Dependent variable	Fixed effects	*b*	*SE*	*p*
Negative FQ	Intercept	1.61	0.03	< .001*
	Gender	0.03	0.03	.21
	Timepoint (linear)	-1.98	0.41	< .001*
	Time spent with peers	0.04	0.02	.04
Positive FQ	Intercept	3.81	0.04	< .001*
	Gender	-0.09	0.04	.02*

Note. *Significant after Bonferroni correction for multiple comparisons (α = 0.05/2 = 0.025).

Figure S1. Results of the best fitting mixed models, showing the effects of (a) Timepoint (linear) on Negative Friendship Quality (FQ), (b) Gender Identity on Positive FQ.



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