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Cornelius Holler

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# The Role of Physical Ability in Team Partner Selection in Adolescent Physical Education: Examining Ability- and Gender-Based Differences

Cornelius Holler *Institute of Sports and Sports Sciences, University of Heidelberg, Germany and Institute of Sport Sciences, Saarland University, Saarbrücken, Germany*

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Address correspondence to Cornelius Holler, Institute of Sport Sciences, Saarland University, Campus Saarbrücken, Geb. B8 1, 66123 Saarbrücken, Germany. E-mail: [cornelius.holler@uni-saarland.de](mailto:cornelius.holler@uni-saarland.de), <https://orcid.org/0009-0008-6599-8971>

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Previous research has highlighted physical ability to be an important factor for adolescents' social acceptance and peer relationships in physical education. However, it has not yet been highlighted whether students of different physical ability and gender differ in their preferences for selecting peers in physical education. A sample of 472 students (48.1% girls) from 21 grade 5 classes in Germany completed questionnaires to assess the role of physical ability on team partner selection in physical education. Using exponential random graph models, this study examined differences in team partner nominations based on physical ability, friendship and gender for students of different physical ability and gender. Results show that high performing students and boys are more frequently chosen as team partners, and that high performing students emphasize the physical ability of their peers significantly more than low performing students. Additionally, all students preferred to play with their friends and peers of the same gender, and no differences in team partner selection could be observed for boys and girls. Further analyses reveal that low performing students are rarely chosen as team partners, especially by high performers. The findings highlight the prominent role of physical ability for peer relationships in physical education and demonstrate how students' selection patterns drive differences in the social acceptance of high and low performing students.

Being sporty is widely recognized as a significant factor for social acceptance and prestige during adolescence (Coleman, 1961; Evans & Roberts, 1987). Physical ability is often cited as an important factor for popularity (Chase & Dummer, 1992), while unathletic or obese adolescents are more likely to experience social exclusion from their peers (Valente et al., 2009). Especially in physical education (PE), where the promotion of positive peer relationships can be regarded as an important educational goal, many qualitative studies remark the social exclusion of low performing students. These studies describe a clear social divide between high and low performing students, where low performing students are routinely victimized by their high performing peers (Metz et al., 2024; Miethling & Krieger, 2004). Physical ability has also been quantitatively examined to be a strong predictor of social status in PE (Grimminger, 2013, 2014).

Recent research has adopted social network analysis to examine peer relationships in PE in order to gain a detailed understanding of the peer processes through which students' social status is constituted. Physical ability has been shown to be an important factor for collaboration in PE (Holler & Schübler, 2024). However, no studies have yet examined potential differences in preferences for peer relationships in PE between high and low performing students as well as boys and girls that can further explain how students gain social status in PE.

This study examines the role of physical ability for team partner selection in PE, focusing on how physical ability and gender affect students' preferences for collaboration. Using a sample of 472 students from 21 grade 5 classes of secondary schools in Germany, exponential random graph models (Lusher et al., 2013) are used to analyze the structure of team partner networks in PE.

# Peer Relationships in Childhood and Adolescence

Striving for social acceptance is regarded as a basic psychological need (Deci & Ryan, 2000) and building positive peer relationships in childhood and adolescence is an important developmental task (Havighurst, 1974). Having positive peer relationships in childhood and adolescence is associated with many positive outcomes like academic achievement (Wentzel et al., 2021) and physical activity (Prochnow et al., 2020). Being excluded, however, has many detrimental effects, such as for students mental health (Røset et al., 2020). Peer relationships in school are especially important as adolescents spend almost half of their time with their peers, primarily at school.

Adolescents strive for social status in school, which is socially constructed within the class and is influenced by the socio-cultural context (McFarland et al., 2014) and peer norms (Veenstra et al., 2018). Students that possess certain characteristics or conform to peer norms are rewarded with social acceptance, whereas students that deviate from the norm are socially rejected. In turn, students with a high social status have the power to enforce and set peer norms, manifesting their central role in the class (Veenstra et al., 2018). Which characteristics are beneficial for social acceptance depends on the social context and the type of relationship. For example, an aggressive student might be rejected from friendships within the classroom but accepted as a valuable teammate in sports teams that value physical toughness (Cillessen & Bukowski, 2018).

Traditionally, research on peer relationships in education has focused on the individual aspects of social acceptance, rather than assessing and analyzing peer relationships directly. For example, the positive relation between academic achievement and social acceptance focuses on the number of nominations received or an average peer rating to measure social acceptance (Wentzel et al., 2021). Such approaches, however, overlook the nature of social relationships, where students are embedded in complex social structures that reciprocally interact with their individual characteristics.

Social network analysis (SNA) offers a promising alternative by explicitly collecting and analyzing relational data (e.g. by asking the students to name their best friends or preferred team partners). Considering the structure of students' relationships is important, because who students associate with can have an impact on academic ambitions (Vit et al., 2024), engagement (Shin, 2022) and achievement (Laninga-Wijnen et al., 2019). SNA offers more detailed information on

how social acceptance is constituted by examining the overall pattern of relationships instead of only focusing on the behaviors and characteristics of individuals (Robins, 2015).

Using SNA to study peer relationships allows to distinguish several mechanisms for the existence of peer relationships that can be categorized into network self-organization, actor attributes and exogenous contextual factors (Lusher & Robins, 2013b). Firstly, peer relationships may form purely as a result of structural processes within the network, independent of actor attributes or exogenous contextual factors. One such effect is triadic closure, which can be described as the tendency to count the friend of a friend as a friend. Secondly, the formation of peer relationships is affected by the individual characteristics of actors. Here, both the senders' and receivers' attribute can come into play. Studies indicate that high performing students are more selective when choosing study partners (*sender effect*), while they are more likely to be nominated themselves (*receiver effect*; Palacios et al., 2024). Receiver effects regarding academic achievement can be found for adolescents' friendships (Gremmen et al., 2017), study partners (Palacios et al., 2019) or team partners in PE (Holler & Schübler, 2024). They emerge because peers can be of (academic) support, as studies have shown that students with high achieving peers have better achievement trajectories (Ryan, 2001). The interplay between actor attributes is also highly relevant for the formation of peer relationships. *Homophily*, the tendency to form relationships with others that are similar to oneself (McPherson et al., 2001), can be found for many attributes in adolescent peer relationships. Students befriend and want to work with others that have the same gender (McMillan, 2022), similar academic achievement (Laniga-Wijnen et al., 2019) or physical activity (Marks et al., 2015). Homophily occurs because people with similar characteristics communicate more easily and perceive each other as more predictable and trustworthy (Laursen & Veenstra, 2021). Lastly, exogeneous context factors, such as other types of peer relationships, can affect the selection of peers. Studies show that friendships are an important precursor to choose peers as study partners (Palacios et al., 2019) or team partners in PE (Schübler et al., 2025).

The tendencies towards homophily or receiver effects may vary depending on the context and type of relationship. Whereas strong gender homophily can be observed in a range of peer relationships in adolescents, studies on academic achievement find mixed results. Homophily effects can oftentimes be observed when studying friendships (Laniga-Wijnen et al., 2019) but sometimes also receiver effects (Gremmen et al., 2017). Conversely, research focused on study

partners mostly find receiver effects for academic achievement, while similarity effects are not as prevalent (Palacios et al., 2019, 2024). These differences can be explored by the distinction between affective and instrumental social ties (Zander et al., 2014). Although friendships can be academically relevant, they are mostly described as being affective relationships that are meant to accomplish socioemotional goals (Bagwell & Bukowski, 2018) and focus on equality rather than competitiveness (Newcomb & Bagwell, 1995). However, study partners collaborate to reach task related goals (e.g., learning a skill) and are therefore more likely to be driven by attributes the others possess that help to reach these goals (e.g., high achievement).

Because of this, recent studies have focused more on studying collaborative ties, including exploring the role of academic achievement in study partner selection (Palacios et al., 2024), and the role of achievement goals for team partner selection in PE (Schüßler et al., 2025).

## Peer Relationships and Physical Ability

Physical ability is a unique attribute in adolescence, as it can be understood both as a general social status norm in adolescent society (e.g., for friendship and admiration, Coleman, 1961) and as an academically relevant attribute within PE (e.g., for being chosen as team partner, and to receive good grades). In school settings, physical ability is positively associated with sociometric status (Dunn et al., 2007) and friendship nominations (Steiger et al., 2021).

Although the role of physical ability for peer relationships in PE is discussed in qualitative PE research (e.g., the potential for conflict between high and low performers in PE: Miethling & Krieger, 2004), few social network studies have highlighted this to date. One study found associations between sport motor competencies and sociometric position in PE based on multiple network generating items (Grimminger, 2013), others related peers' perceived physical ability to social status in PE group work (Hollett et al., 2020). However, these studies focused exclusively on the number of nominations received as an indicator of status and did not include network structural analyses.

## Conceptualizing Physical Ability

There has been a long discussion about the conceptualization and operationalization of “ability” in PE within the sports pedagogy literature (e.g., the discussion of “PE-as-sport” in England; Berkshire et al., 2025). The German PE curriculum has, in the last decades, shifted away from

focusing solely on normed sports (e.g., soccer, volleyball) and a narrow definition of physical ability (i.e., physical fitness and motor skills) towards addressing sports from a broader perspective and helping students acquire motor, cognitive, social and emotional competencies to be able to act autonomously in sports-related situations (Gerlach et al., 2014). Following from this, standardized motor tests, that assess students' endurance and strength capabilities or basic motor skills, are not sufficient to measure the complex competencies students acquire and display during PE. While some competence-based tests for performance in team sports are being developed for sports club settings (Reinders et al., 2025), they have not been established for use in PE yet.

Additionally, the question arises as to whether “objective” measures of ability are the most informative measure for research on peer relationships. A growing body of research highlights the important role of (peer) perceptions in shaping peer relationships and behavior. In studies of adolescent drug use, perceptions of friends' drug use were better predictors of adolescents' own drug use than actual use (Bauman & Ennett, 1996). In school classes in Hungary, being perceived by peers as belonging to the Roma minority was a significant predictor of bullying while self-reported ethnicity was not (Kisfalusi et al., 2020). Peer perceptions of physical ability have been shown to correlate exceptionally highly with a teacher rating of physical ability ( $r = .70$ ) and to be a strong predictor of team partner nominations (Holler & Schüßler, 2024). Students can be regarded as having unique knowledge of their peers' abilities (Gest et al., 2008). Following this line of research, the current study uses peer nomination procedures to assess the perceived physical ability of students in PE.

## ***The Role of Gender***

Gender homophily plays an important role for peer relationships in childhood and adolescence. Even though the strength of gender homophily can vary based on relationship strength (e.g., Kretschmer et al., 2024), the tendency consistently appears both in affective networks (e.g., friendships; Laninga-Wijnen et al., 2019) and collaborative networks (e.g., study partners; Palacios et al., 2024).

Beyond homophily effects, the PE context raises further gender-related issues. The strong focus on winning and the presence of hegemonic masculinity in PE may disadvantage girls (English, 2017) and privilege boys (Metz et al., 2024). Gender stereotypes are also perpetuated in

PE (Cárcamo et al., 2021) which may explain why boys consistently report a higher physical self-concept than girls (Marsh et al., 2007; Mascret et al., 2021). These factors could lead to boys being more likely to be chosen as team partners in PE.

However, physical ability may matter differently for boys and girls when choosing peers in PE. Boys tend to rank physical ability as their primary criterion for popularity, while girls prioritize physical appearance (Chase & Dummer, 1992). Similarly, the association of physical ability and social acceptance may differ for boys and girls. Whereas one study found positive associations for boys and girls (Dunn et al., 2007), a more recent study in German PE classes only found significant associations for boys (Grimminger, 2013). Choosing team partners in PE, girls seemed to prefer their (female) best friend whereas boys wanted to play with the highest performing (male) peers (Grimminger, 2014). These findings suggest that boys may emphasize physical ability more than girls when choosing team partners in PE whereas girls prefer to play with their friends instead.

## Physical Education as a Unique Social Context for Peer Relationships

In addition to motor skill learning, many curricula set lifelong physical ability, mental and physical well-being, and personal and social development as PE goals (Hardman, 2008). In this context, peer relationships play an important role in PE, both as an objective in terms of personal and social development and as a factor in achieving other objectives. Positive peer relationships have been associated with physical activity (de la Haye et al., 2011; Prochnow et al., 2020), whereas social exclusion in PE has been linked to mental health issues (Røset et al., 2020). However, when examining peer relationships in PE, the specific context and its consequences for peer relationships must be considered.

First, PE constitutes a unique environment within the school setting, as the students' performance during PE is highly visible. This is because physical tasks are easier to observe than the cognitive tasks that are the focus of other subjects. This is also supported by the open environment of the gym, which is not constrained by seating arrangements or desks. While this informs students about the performance of their peers, which they can accurately evaluate (Holler & Schüßler, 2024), it also leads to the exposure of students' bodies. Even though this can be motivating for some students, who feel secure in showing their skills in front of others, it can

be devastating for others (Miethling & Krieger, 2004). The visibility of their bodies and abilities, especially when combined with physical contact or body-related remarks, can lead to feelings of shame (Hunger & Böhlke, 2017). Whether a student feels secure in presenting themselves or not may be linked to their physical ability. One strategy for avoiding feelings of shame could be a stronger connection to friends in PE. Friends can provide support and a safe context for uncertain situations or those involving body exposure (Miethling & Krieger, 2004). Thus, playing with their friends and feeling safe may be a priority for low performing students.

Second, the type of collaboration that is present for team partners in sports games differs substantially from other contexts such as study partners or collaborating in a group project, because of different aims. In traditional group work or study partner settings, collaboration oftentimes consists of learning together and creating an output at the end of the process. Usually, the learning process is not evaluated or graded, so when one student makes a mistake, the others can step in and help them learn, without it having negative consequences on the final evaluation. Although they collaborate, team partners in sports games have a higher goal in mind: winning. If one teammate makes a mistake, this has immediate negative consequences for the whole team, and the others can only partially equalize (e.g., by trying to get the ball back from the other team). Sports games can be seen as performance situations, as every action has a direct consequence for the result of the game. Even though PE should aim to promote the personal and social development of students, it regularly emphasizes competition and winning (English, 2017). Because this is mostly achieved through a focus on traditional sports and the development of motor skills (Hardman, 2008), this can affect students' choices for team partners. The focus on winning should lead to a higher emphasis on possessing high physical ability for nominating team partners, especially for high performing students, who have been shown to want to compete with their peers (Bakadorova & Raufelder, 2015). The tendency for other students to disregard and exclude low performing students has been qualitatively documented in several studies, that express themselves through exclusion from teams or acts of verbal and physical violence (e.g., Metz et al., 2024).

The dependency on others' physical ability for winning in sports game could also be connected to choosing friends as team partners. Previous studies have shown the general preference of students to work with students they like or are friends with in school (Hartl et al., 2015; Palacios et al., 2019) and in PE (Schüßler et al., 2025). However, differences in

considering friends versus high performing peers could emerge between high performing and low performing students. On the one hand, low performing students might be convinced that they are unable to meet performance requirements (Metz et al., 2024). Here, failure can be processed more easily within the group of friends (Miethling & Krieger, 2004). Therefore, low performing students are expected to have the desire to surround themselves with friends during sports games. On the other hand, high performing students want to compete with their peers (Bakadorova & Raufelder, 2015), so they may be less focused on playing together with their friends. Instead, high performing students are expected to put more emphasis on physical ability than lower performing peers. These consequences following from the characteristics of PE contrast with those from other contexts. A recent study examined study partner networks in school and found that “high achievers may be more inclined to study with friends because they have already achieved academic success” (Palacios et al., 2024, p. 693). As success in PE, in contrast to other school subjects, depends not only on the students’ own performance but also on that of their team partners, it is not expected that this will be the case for team partner nominations in PE.

Although some studies have highlighted differences in support seeking behaviors (Bakadorova & Raufelder, 2015) and study partner choices (Palacios et al., 2024) between high and low performing students, no studies have addressed these differences within the context of PE.

## The Current Study

This study examines ability- and gender-based differences of team partner selection for sports games in grade 5 PE in Germany. Using exponential random graph models (ERGM; Lusher et al., 2013), the study is able to examine team partner choices while differentiating effects from network self-organization, actor attributes or exogenous contextual factors.

In line with previous research, it is expected that high performing students are more likely to be nominated as team partners in a sports game (*hypothesis 1a*). Additionally high performing students are expected to put more emphasis on physical ability when selecting their team partners than low performing students (*hypothesis 1b*). Because being with friends in PE can give students a sense of security, it is expected for all students to nominate their friends as team partners (*hypothesis 2a*). As high performing students are reported to want to compete with their peers, they may disregard their friends in order to nominate high performing peers.

However, low performers might be convinced to be unable to meet performance requirements, thus are expected to be more likely to nominate their friends as team partners compared to high performers (*hypothesis 2b*). Gender homophily plays an important role for peer relationships in childhood and adolescence, but peer relationships in PE are also influenced by a focus on competition and gender stereotypes in PE. It is therefore expected that boys are more attractive team partners than girls (*hypothesis 3a*), but that students generally prefer to play with students of the same gender (*hypothesis 3b*). Lastly, given that boys and girls differ in their preferences regarding physical ability and friendship priorities, it is expected that girls will be less likely to select team partners based on physical ability and more likely to select their friends as team partners (*hypothesis 4*).

## Methods

### Participants and Procedure

Data from 517 students in 23 secondary school classes in Baden-Württemberg, Germany, were collected in the spring of 2024 as part of a larger longitudinal data collection. Students completed standardized questionnaires, including both validated psychological questionnaires and peer nominations to collect social network data. Each student was assigned a random number code to represent them in the questionnaire. During the data collection, students were given a paper questionnaire and a list of their classmates' names alongside their respective number codes, which they used to nominate peers within the questionnaire.

Two classes were excluded from the analyses due to low participation rates (<60%; following Harks & Hannover, 2020). Students with missing data in the variables used were omitted from ERGM analyses. Because of low rates of missing data, no imputation techniques were employed. The final sample consisted of 472 students from 21 classes with an average participation rate of 86%, ranging from 66.7% to 100%. Students and parents received information about the study and a consent form in advance of the data collection. Written consent from a parent or legal guardian to participate in the study was required from all participants. The study was approved by the ethics committee of the faculty of Behavioural and Cultural Studies of the University of Heidelberg (AZ Hol 2023 1/1).

## Measures

### *Social Network Data*

Students were asked to identify their best friends (friendship, max. 5 nominations), who they would like to be team partners with when playing a sports game in PE (team partner, max. 10 nominations), which classmates were particularly good at PE (high performing, max. 10 nominations) and which were not so good (low performing, max. 10 nominations). Each network was collected and analyzed separately.

The type of sports game was not specified in the questionnaire to allow students to answer according to their current experiences in PE. Sports games in German PE can consist of the “big” sports games like soccer, volleyball, handball or basketball. However, the curriculum requires an integrative approach to teaching sports games in grade 5 which consist of adapted “small” games that are aimed at teaching the students basic techniques and an understanding of team sports (Ministerium für Kultus, Jugend und Sport Baden-Württemberg, 2016; Pfitzner, 2021).

Although giving students unlimited choices would be ideal for assessing social networks, the number of allowed nominations was limited both to focus their nominations on the most relevant peers (e.g., best friends) and to limit fatigue when filling in the questionnaire. The maximum outdegree was included as a constraint in the ERGM to control for the potentially skewed outdegree distribution.

### *Physical Ability*

Using the nominations of the high- and low-performing students, a peer score was calculated by subtracting the normalized indegree of each student in the low-performing network (i.e., indegree divided by the maximum possible indegree) from their corresponding value in the high-performing network. The resulting measure, ranging from -1 to 1, represents the classes opinion of each student’s physical ability. A positive value indicates that a student received more high performing nominations than low performing nominations, whereas a negative value indicates that a student received more low performing nominations. This procedure is often used to create a measure of social acceptance (Dunn et al., 2007) or peer academic reputation (Gest et al., 2008) and has also been adapted to assess peer athletic reputation in PE (Howle et al., 2016). Previous studies have found that positive and negative nominations independently predicted social

acceptance. However, confirmatory factor analysis has supported a single-factor model, indicating that a composite score is more appropriate (Gest et al., 2008; Howle et al., 2016).

In order to explore differences in nomination behavior and social acceptance of students with different levels of physical ability, students were categorized into three groups based on their peer score. Students whose peer score was more than one standard deviation below the class mean were categorized as *low performing* (15.5%), students whose peer score was more than one standard deviation above the mean were categorized as *high performing* (18.2%), whereas students within one standard deviation of the mean were categorized as *moderate performing* (66.3%).

## Gender

Gender was assessed in the questionnaire and included an option for students to identify as non-binary. The final sample consisted of 227 girls and 245 boys, with no students identifying themselves as non-binary.

## Analytical Strategy

ERGMs were conducted to test the hypotheses, which allow to analyze the effects of individual attributes (e.g., physical ability) as well as dyadic covariates (e.g., friendship). In addition, ERGMs allow controlling for structural network effects (e.g., reciprocity or triadic closure), which is crucial when examining individual behavior in groups. It is important to distinguish whether a student is nominated as a team partner in a sports game because of their high level of physical ability or because they already have an indirect connection through another student, leading to triadic closure. Ignoring these effects could lead to a biased interpretation of the parameters.

Multi-group ERGMs were applied to run the same model on all networks simultaneously using the *ergm.multi* package (version 0.2.1, Krivitsky, 2024) in R (version 4.4.1, R Core Team, 2025). This method improves on the meta-analytic approach often used in social network studies, as the increased statistical power allows for more complex models (e.g., using interaction effects) to be fitted that would not converge in single-class models (Krivitsky et al., 2023).

## Model Specification

## Structural Network Effects

To model and control for network endogenous effects, several structural parameters were included in the analyses (following Lusher & Robins, 2013a). *Density* refers to the general tendency of students to nominate others as team partners. *Reciprocity* accounts for students nominating each other as team partners. *Twopath* measures whether students that nominate many peers as team partners also receive many nominations. *Transitive closure* describes students forming closed triadic structures, for instance nominating a student because a preferred team partner also nominates this student as team partner. *Indegree*, sometimes called preferential attachment, measures the amount of centralization of team partner nominations on few students. Finally, *outdegree* describes the distribution of outgoing nominations in the network. Here a negative coefficient indicates that actors nominate a similar number of peers as team partners while a positive coefficient shows that some actors are more active than others.

## Individual Attributes

Individual attributes in ERGM, in this case physical ability and gender, were included under three different assumptions. First, the *receiver effect* describes the tendency to nominate others who have a high (in the case of continuous variables) or a specific (in the case of categorical variables) characteristic of a particular attribute, regardless of the sender's attribute. These effects were included to test whether high performing students and boys are more frequently chosen as team partners. Second, the *sender effect* describes the tendency to change nomination behavior based on one's own characteristics, referring to that high performing students are more selective in nominating team partners than low performing students. Third, the relation between the attributes of the sender and the receiver is often important. *Homophily* refers to the tendency to nominate others who are similar to oneself: if students of the same gender are more likely to nominate each other as team partners in PE. For continuous variables, this is measured as *heterophily* by calculating the absolute difference between actor attributes. This was included to test whether students with similar physical ability are more likely to nominate each other as team partners. For this parameter, a negative coefficient would imply homophily, if students with a smaller difference in physical ability were more likely to nominate each other. In order to avoid confusion while maintaining statistical correctness, the term heterophily is retained in the tables, whereas the term homophily is used to describe the tendency of students to nominate similar

peers in the text.

## **Network Attributes**

To account for students being nominated as team partners because they are also friends, friendship ties are included into the ERGMs as dyadic covariates.

## **Interaction effects**

In order to analyze the difference in nomination behavior, the effects for physical ability (receiver and heterophily), friendship and gender were interacted with the physical ability of the sender. Thus, differences in team partner selection between lower and higher performing students are addressed.

## **Model Selection**

Five models were developed to test the hypotheses. The ability models (1.1 & 1.2) include only structural parameters and physical ability while the full models (2.1 & 2.2) include additional covariates for friendship ties and gender to control for the associations of physical ability with these known covariates. Models 1.1 and 2.1 include only the main effects, while models 1.2 and 2.2 also include the interaction effects with the physical ability groups. Additionally, model 2.3 included all covariates as well as interaction effects testing for differences in team partner choices between boys and girls.

Following Duxbury's (2021) approach for diagnosing and dealing with multicollinearity in ERGM, variance inflation factors (VIF) for model parameters were calculated and then used to simplify the models in cases of collinearity. This approach warns against VIFs over 20, as they increase the risk of inconsistent parameter estimates and discourages strongly against using models with VIFs over 150. In the calculated models, two structural parameters (twopath and triadic closure) showed VIF values above 20. Stability analyses were run to confirm the reliability of the findings and showed no substantial variation in parameter estimates and standard errors. Therefore, no predictors were excluded from the models. A detailed description of this procedure can be found in supplemental material A. Goodness of fit statistics of the final models are displayed in supplemental material B. The R code used for data preparation and analysis can be found in supplemental material C.

# Results

## Descriptive Analyses

Table 1 provides an overview of the descriptive statistics of the network characteristics. Comparing the networks using paired t-tests, the friendship networks have higher reciprocity ( $t = 4.65$ ,  $df = 20$ ,  $p < .001$ ) and lower indegree centrality ( $t = -8.87$ ,  $df = 20$ ,  $p < .001$ ) than the team partner networks. This means that students are more likely to reciprocate friendships than team partner nominations and are more evenly distributed across the network. The team partner network, however, has more unidirectional ties and leads more often to central actors, possibly high performing students. Comparing the density and average degree of the two networks is not meaningful, as this difference is influenced by the different number of possible nominations in the questionnaire.

Table 2 displays descriptive statistics for physical ability and correlation analyses. The peer score of physical ability ( $M = .10$ ,  $SD = .28$ ) is slightly positive on average, indicating that students generally received more positive than negative nominations. It ranges from  $-.78$  to  $.81$ , demonstrating that for the highest and lowest performing students in the sample, approximately 80% of the class nominated these students as high or low performing. Girls are attributed a lower physical ability on average than boys, and their peer score does not deviate as far from the mean as for boys. This indicates that girls are seen neither as the highest or lowest performers in the class, but on average perceived as less skilled than boys.

The role of physical ability for social acceptance can be demonstrated, at a basic level, by the correlation of physical ability with the normalized indegree in the networks (Table 2). Physical ability correlates moderately ( $r = .45$ ,  $p < .001$ ) with the number of friends in class and exceptionally highly ( $r = .78$ ,  $p < .001$ ) with the number of team partner nominations received. The correlations between physical ability and friendship and team partner indegree are significant for both boys and girls. Fisher's z-test for differences of correlations revealed no significant difference in the association between physical ability and friendship indegree ( $z = 1.885$ ,  $p = .059$ ). However, boys' team partner indegree is significantly more related to their physical ability ( $z = 4.562$ ,  $p < .001$ ) than girls'. This indicates that physical ability is an important attribute for all students, but that it is more important for boys than for girls.

The differences in social acceptance become evident when considering the average

number of friendship and team partner nominations received by performance group and gender (Table 1). On average, high performers are nominated as friends more than twice as often as low performers, and as team partners almost four times as often. Girls and boys are similarly often nominated as friends. However, boys receive, on average, two team partner nominations more than girls. This may be explained by the difference in peer perceived physical ability between boys and girls.

Although these descriptive values do not account for the structural characteristics of the network, it becomes clear that physical ability plays an important role for social acceptance in friendship and team partner networks in PE. Physical ability is more attributed to boys but emerges as an important characteristic for boys' and girls' friendship and team partner ties.

Lastly, students nominate many their peers as friends and team partners, as the average outdegree is close to the maximum allowed number of nominations.

**Table 1**

*Overview of Descriptive Statistics of Network Measures.*

Network Parameters	Friendship <i>M (SD)</i>	Team Partner <i>M (SD)</i>
Density	.17 (.02)	.33 (.04)
Reciprocity	.68 (.08)	.60 (.06)
Indegree Centralization	.12 (.02)	.22 (.06)
Average Indegree	3.67 (2.01)	7.15 (3.79)
- Low Performing	1.90 (1.51)	3.05 (2.27)
- Moderate Performing	3.83 (1.91)	6.93 (3.00)
- High Performing	4.60 (1.88)	11.4 (2.96)
- Girls	3.57 (1.93)	6.05 (3.15)
- Boys	3.76 (2.09)	8.17 (4.04)
Average Outdegree	4.14 (1.23)	8.14 (2.36)

Note.  $N_{\text{Classes}} = 21$ ;  $N_{\text{Students}} = 472$ ;  $N_{\text{Girls}} = 227$ ;  $N_{\text{Boys}} = 245$ .

**Table 2**

*Correlations between Physical Ability and Normalized Indegree in the Friendship and Team Partner Networks with Confidence Intervals, and Descriptive Statistics of the Physical Ability Measure.*

	Gender	Friendship	Team Partner	<i>M (SD)</i>	<i>(Min, Max)</i>
Physical Ability	Girls	.36*** [.24, .47]	.63*** [.55, .70]	.02 (.22)	(-.68, .55)
	Boys	.50*** [.40, .59]	.82*** [.78, .86]	.17 (.30)	(-.78, .81)
	Total	.45*** [.37, .52]	.78*** [.74, .81]	.10 (.28)	(-.78, .81)

Note.  $N_{\text{Students}} = 472$ ;  $N_{\text{Girls}} = 227$ ;  $N_{\text{Boys}} = 245$ . 95% confidence interval in brackets. Physical Ability = peer score calculated from subtracting the normalized indegrees of the high performing and low performing networks; scores range from -1 to 1; higher scores indicate higher physical ability. Friendship = normalized indegree of the friendship network, scores range from 0 to 1. Team Partner = normalized indegree of the team partner network, scores range from 0 to 1.

\*\*\* $p < .001$ .

## The Analysis of Team Partner Network Structure

Table 3 displays the ERGM results for the four models that analyze students' preferences for team partners in PE. Table 4 shows model 2.3 investigating gender interactions.

### Network Structural Parameters

In terms of the structural parameters that are fundamental to social networks, the patterns found

in the team partner networks mimic those of other network studies looking at collaboration or friendship networks in adolescence. Students show a general tendency to reciprocate team partner nominations, to have a negative association between indegree and outdegree, to show preferential attachment and to form triadic constellations.

## **The Role of Physical Ability—Ability Models**

Students' physical ability has an important effect on the network structure of team partners. The main effects of physical ability are shown in Model 1.1. Consistent with hypothesis 1a, students with high physical ability are more likely to be nominated by others (*Est.* = 2.399, *CI* = [2.159, 2.639], *p* < .001) but are less likely to nominate other students (*Est.* = -0.825, *CI* = [-1.083, -0.568], *p* < .001). Students additionally preferred to play with similarly performing peers (*Est.* = -0.674, *CI* = [-0.819, -0.528], *p* < .001).

In Model 1.2, the interaction effects with the physical ability sender effect are included. The main effect of physical ability receiver stays significant, indicating that low performers nominate others on the basis of high physical ability. The interaction effect highlights, that the higher the physical ability of the sender, the more important the physical ability of the receiver becomes (*Est.* = 1.18, *CI* = [0.532, 1.829], *p* < .001; hypothesis 1b). For physical ability homophily, no significant differences can be observed between low and high performers (*Est.* = 0.136, *CI* = [-0.499, 0.772], *p* = .674).

## **Controlling the effects of physical ability with friendship and gender**

Models 2.1 and 2.2 mirror models 1.1 and 1.2 but add friendship and gender homophily as control parameters to examine if the effects of physical ability hold up against the effects of known covariates. In Model 2.1, the main effect of high physical ability remains significant (*Est.* = 2.586, *CI* = [2.295, 2.878], *p* < .001) as well as the physical ability homophily effect (*Est.* = -0.288, *CI* = [-0.515, -0.061], *p* = .013). In addition, students are more likely to choose their friends as team partners (*Est.* = 2.453, *CI* = [2.279, 2.627], *p* < .001; hypothesis 2a). Boys are significantly more likely to be chosen as team partners (*Est.* = 0.272, *CI* = [0.156, 0.388], *p* < .001; hypothesis 3a) but are less active in nominating others (*Est.* = -0.257, *CI* = [-0.377, -0.137], *p* < .001). Lastly, in line with hypothesis 3b, peers of the same gender are significantly more

likely to be selected as team partners ( $Est. = 0.863$ ,  $CI = [0.725, 1.002]$ ,  $p < .001$ ) than peers of a different gender. Model 2.1 shows the significant effect of possessing high physical ability on team partner nominations independent of significant friendship and gender associations.

Model 2.2 includes all parameters and interaction effects of physical ability sender. Regarding physical ability, the same associations emerge as in model 1.2. Students with high physical ability are more frequently chosen as team partners, and high performers put more emphasis on the physical ability of their peers (hypotheses 1a & 1b). There is significant physical ability homophily that is independent of the physical ability of the sender. Finally, in contrast to hypothesis 2b, friendships play an important role for students of all ability, as the interaction effect between friendship and physical ability sender is non-significant ( $Est. = -0.366$ ,  $CI = [-0.983, 0.252]$ ,  $p = .246$ ).

### ***Differences between boys and girls in nominating team partners***

Model 2.3 (Table 4) examines differences in team partner choices between boys and girls. The results show that boys were neither more inclined to nominate high performing peers as team partners ( $Est. = -0.369$ ,  $CI = [-0.827, 0.088]$ ,  $p = .114$ ) nor did they nominate their friends less than girls ( $Est. = 0.056$ ,  $CI = [-0.284, 0.396]$ ,  $p = .748$ ), contrary to hypothesis 4.

**Table 3**

*Multi-group ERGM Results for Examining the Structure of the Team Partner Network.*

		Ability Models				Full Models			
		Model 1.1		Model 1.2		Model 2.1		Model 2.2	
Parameter		<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>
Structural Parameters	Density	-4.081***	[-4.441, -3.721]	-3.995***	[-4.368, -3.622]	-3.448***	[-3.848, -3.049]	-3.457***	[-3.862, -3.052]
	Reciprocity	1.365***	[1.202, 1.528]	1.38***	[1.216, 1.545]	0.85***	[0.671, 1.028]	0.853***	[0.67, 1.036]
	Twopath	-0.114***	[-0.135, -0.094]	-0.119***	[-0.141, -0.098]	-0.046***	[-0.069, -0.024]	-0.05***	[-0.073, -0.028]
	Indegree	2.494***	[2.031, 2.958]	2.143***	[1.654, 2.632]	0.873**	[0.302, 1.444]	0.609*	[0.043, 1.174]
	Outdegree	0.037	[-0.386, 0.46]	-0.105	[-0.547, 0.337]	-1.881***	[-2.387, -1.374]	-1.954***	[-2.478, -1.43]
	Triadic closure	1.747***	[1.65, 1.843]	1.721***	[1.625, 1.817]	0.853***	[0.736, 0.971]	0.846***	[0.728, 0.964]

		Ability Models				Full Models			
		Model 1.1		Model 1.2		Model 2.1		Model 2.2	
Parameter		<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>
Physical Ability	Receiver ( <i>H1a</i> )	2.399***	[2.159, 2.639]	2.229***	[1.941, 2.518]	2.586***	[2.295, 2.878]	2.409***	[2.069, 2.748]
	Receiver x Sender ( <i>H1b</i> )			1.18***	[0.532, 1.829]			1.829***	[0.832, 2.826]
	Sender	-0.825***	[-1.083, -0.568]	-0.983***	[-1.401, -0.565]	-0.401**	[-0.693, -0.109]	-0.723**	[-1.228, -0.218]
	Heterophily	-0.674***	[-0.819, -0.528]	-0.365**	[-0.599, -0.132]	-0.288*	[-0.515, -0.061]	0.129	[-0.202, 0.459]
	Heterophily x Sender			0.136	[-0.499, 0.772]			0.404	[-0.316, 1.125]
Networks	Friendship ( <i>H2a</i> )					2.453***	[2.279, 2.627]	2.456***	[2.271, 2.641]
	Friendship x Physical Ability Sender ( <i>H2b</i> )							-0.366	[-0.983, 0.252]

		Ability Models				Full Models			
		Model 1.1		Model 1.2		Model 2.1		Model 2.2	
Parameter		<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>	<i>Est.</i>	<i>CI</i>
Gender	Boy Receiver ( <i>H3a</i> )					0.272***	[0.156, 0.388]	0.274***	[0.159, 0.389]
	Boy Sender					-0.257***	[-0.377, -0.137]	-0.266***	[-0.388, -0.145]
	Homophily ( <i>H3b</i> )					0.863***	[0.725, 1.002]	0.882***	[0.744, 1.019]

*Note.*  $N_{\text{Classes}} = 21$ ;  $N_{\text{Students}} = 472$ . *Est.* = ERGM parameter estimate. *CI* = 95% confidence interval. Physical Ability = peer score

calculated from subtracting the normalized indegrees of the high performing and low performing networks; scores range from -1 to 1;

higher scores indicate higher physical ability. For gender effects, girls constitute the reference group.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

**Table 4***Multi-group ERGM results analyzing gender differences in team partner nominations in PE.*

		Model 2.3	
	Parameter	<i>Est.</i>	<i>CI</i>
Structural Parameters	Density	-3.415***	[-3.829, -3]
	Reciprocity	0.847***	[0.668, 1.026]
	Twopath	-0.047***	[-0.069, -0.024]
	Indegree	0.892**	[0.311, 1.473]
	Outdegree	-1.912***	[-2.43, -1.395]
	Triadic closure	0.848***	[0.731, 0.965]
Physical Ability	Receiver	2.831***	[2.429, 3.233]
	Receiver x Boy Sender ( <i>H4</i> )	-0.369	[-0.827, 0.088]
	Sender	-0.664**	[-1.077, -0.251]
	Sender x Boy	0.388	[-0.045, 0.821]
	Heterophily	-0.491**	[-0.86, -0.121]
	Heterophily x Boy Sender	0.217	[-0.242, 0.676]
Networks	Friendship	2.426***	[2.187, 2.665]
	Friendship x Boy Sender ( <i>H4</i> )	0.056	[-0.284, 0.396]
Gender	Boy Receiver	0.252***	[0.132, 0.372]
	Boy Sender	-0.278**	[-0.484, -0.072]
	Homophily	0.893***	[0.757, 1.029]

*Note.*  $N_{\text{Classes}} = 21$ ;  $N_{\text{Students}} = 472$ . *Est.* = ERGM parameter estimate. *CI* = 95% confidence interval. Physical Ability = peer score calculated from subtracting the normalized indegrees of the high performing and low performing networks; scores range from -1 to 1; higher scores indicate higher physical ability. For gender effects, girls constitute the reference group.

\*\* $p < .01$ . \*\*\* $p < .001$ .

## Team Partner Nominations by Performance Group

The results of the ERGM showed a positive main effect of physical ability of the receiver as well as a positive interaction effect between the physical ability of the sender and of the receiver. This means that high performing students are more likely nominated by all students, but especially by students with higher ability themselves. To put the ERGM coefficients into perspective and to show the differences in nomination preferences of students of different levels of physical ability, the percentage of realized team partner nominations (dyads that are team partner nominations) in relation to all possible nominations (all dyads) were calculated between all performance groups. Figure 1 displays the group-based percentages, that account for differences in group size, and the absolute number of nominations in the bottom left.

Across all students, more than half of all possible nominations to high performers are realized team partner nominations, whereas this is less than 1/3 of dyads towards moderate performers and only 13.9% of dyads towards low performers. Whereas moderate performing students nominate their peers in a similar way, high performing and low performing students deviate from this distribution. Low performing students nominate their low performing peers more often than the other performance groups do. However, they also nominate almost 40% of possible high performers, resulting in more than twice as many nominations reaching high performers than low performers, showing the strong preference to play with high performing students in a sports game. However, high performing students mainly prefer to play with other high performing and moderate performing students. High performing students realize less than 10% of all possible dyads towards low performing students, which are only 25 nominations across the whole sample. The results exemplify the preference for low performing students to associate with high performing students, whereas high performing students distance themselves

from playing together with low performing students.

## Figure 1

*Heatmap of the team partner nominations separated by performance group.*

[insert figure 1 here]

*Note.*  $N_{Dyads} = 10454$ . The values represent the percentage of realized team partner nominations in relation to all possible dyads between the performance groups. The numbers on the bottom left represent the number of realized dyads and the number of possible dyads that are used to calculate the percentage. Physical Ability = peer score calculated from subtracting the normalized indegrees of the high performing and low performing networks; scores range from -1 to 1; higher scores indicate higher physical ability. High Physical Ability = students whose physical ability is more than one standard deviation above the class mean. Moderate Physical Ability = students whose physical ability is within one standard deviation from the class mean. Low Physical Ability = students whose physical ability is more than one standard deviation below the class mean.

## Robustness Checks

Several further analyses were conducted to ensure the robustness of findings and can be found in supplemental material D.

Firstly, ERGM results were replicated using the categorization of students into low, moderate and high performing groups. This was done to further understand the positive interaction effects using the continuous physical ability score. The results showed that moderate performing students were significantly more likely to be nominated as team partners as low performing students, and that high performing students were significantly more likely to be nominated compared to both low and moderate performing students. Conversely, high performers were significantly less likely to nominate low and moderate performing students compared to other high performers. The results were also replicated using two more groupings to

ensure robustness.

Secondly, the heatmap results were checked by replicating the heatmap using the two other groupings as well as splitting the heatmap by the gender of the sender. Similar to the results of model 2.3, similar patterns emerged for boys and girls, even though descriptively, boys nominated more high performers than girls.

## Discussion

Previous research has highlighted physical ability to be an important characteristic for social acceptance in PE and has documented conflicts between high and low performing students in PE which can include the social exclusion of low performing students from their peers. This study used multi-group ERGMs on a sample of 472 students from 21 secondary school classes to examine the importance of physical ability for peer relationships in PE and how preferences for team partners differ between students of different physical ability and gender.

The analyses show the prominent role of physical ability for team partner nominations that lead to large disparities in social acceptance between high and low performing students. This may be driven by multiple factors. As possessing high physical ability is a positive norm for students, and competition and winning is emphasized in PE (English, 2017), all students may desire to win in sports games to gain social status with their peers and teacher. Contrary to qualitative studies which suggest that low performing students distance themselves from high performing students (Miethling & Krieger, 2004), the results show that low performing students still prefer high performing students as team partners. At the same time, high performers are very reluctant to choose low performers as team partners, because it might hinder them from winning the sports game. Additionally, as the tendency to nominate similar performing peers as team partners did not vary between students, high performing students might also nominate other high performing students because they are similar to themselves, thereby exacerbating the disparities.

Another contributing factor to the differences in social acceptance between high and low performing students might be friendship. All students show a strong tendency to nominate their best friends as team partners in PE. However, not only do low performers have fewer friends than high performers, but friendship and physical ability may also be related. Research shows that adolescents are similar to their friends regarding a range of different characteristics including academic achievement (Laninga-Wijnen et al., 2019), physical activity (de la Haye et

al., 2011) and health lifestyles (adams et al., 2022). Given that physical ability is an important and salient characteristic, it is therefore plausible that physical ability similarity also plays a relevant role in the formation of friendships in school, further contributing to differences in social acceptance. The interplay between friendship and team partner relationships in relation to physical ability cannot be disentangled cross-sectionally. Future studies should use longitudinal, multiplex SNA to analyze the co-evolution of the two networks in relation to physical ability.

Lastly, gendered norms also affect the differences in social acceptance between students. All students prefer to play with same-gendered peers, but at the same time, boys are attributed higher physical ability than girls and are generally preferred to girls as team partners. This is in line with gender stereotypes and hegemonic masculinity in PE (English, 2017; Metz et al., 2024). Even though both boys and girls value high physical ability in their team partners, because boys are more likely to be high performing and to receive more team partner nominations, this may contribute to boys being very central in PE, disadvantaging girls. The prominence of boys in PE might also be connected to the type of sports game that was played in PE. As this was not specified in the questionnaire, the students were instructed to answer based on their recent PE experiences, which might have included sports that were perceived as stereotypically male. Future studies should take the type of sport addressed in PE into account to explore possible changes in gendered perceptions of ability and peer relationships.

Taken together, students create a social hierarchy in PE which is predominantly determined by students' perceived physical ability. On the one hand, this might lead to negative long-term consequences for low performing students, as low social acceptance has been linked to many negative individual outcomes such as mental health problems (Røset et al., 2020), internalizing and externalizing behaviors (Bagwell & Bukowski, 2018) or lower physical ability (Prochnow et al., 2020). On the other hand, strong inequities in peer relationships might lead to less behavioral engagement overall (Cappella et al., 2013), impairing all students' experiences in PE.

Besides motor skill development and lifelong physical activity, the personal and social development is a main curricular aim of PE (Hardman, 2008). For that reason, preventing a strong social hierarchy and improving the social acceptance of low performing students and girls should be an important PE goal.

One approach could be to reduce the excessive focus on competition and winning in PE

and expand students' understanding of ability in PE. Although competition is an essential part of sports and does not necessarily have a negative impact on peer relationships, highlighting other aspects of sports that have different conceptualizations of ability might improve the social acceptance of students that do not conform to the competition-oriented understanding of physical ability. One concept prevalent in German PE curricula are the six *perspectives of meaning*. Competing against each other is only a part of one of the six perspectives. Others emphasize, for instance, physical expression, daring and taking responsibility or promoting health and creating health awareness (Wibowo et al., 2023, p. 239). Although all actions in PE can be interpreted and evaluated in terms of ability, the meaning of what constitutes ability can vary depending on the perspective of meaning being focused on in PE. For example, high performance might mean that a student has the courage to express themselves through dance, or attempts to do a parkour move that they did not dare to do before.

This approach could also help to reduce gender stereotypes and improve social acceptance of girls in PE. An intervention study using dancing classes in school showed an increase in boys nominating girls as cooperation partners (Zander et al., 2014). Future studies should examine how different PE practices and which sports are addressed affect the formation and development of peer relationships, particularly among high- and low-performing students, and between boys and girls.

## Strengths and Limitations

This study is the first to assess differences in team partner selection in PE for students of different levels of physical ability and gender. Employing SNA to analyze peer relationships in PE builds on previous studies, which have often used qualitative or attribute-based methods. Our approach allows to model the structure of peer relationships that explain students' social acceptance. Ability- and gender-based differences in nomination behavior could be identified that were not assessed before. The findings emphasize the importance of physical ability for peer relationships in PE but also highlight the role that gender and friendship play in team partner choices.

However, a few limitations need to be addressed. First, the sample consisted exclusively of 5th year students, which restricts the generalizability of the results. As students age, their perceptions of physical ability and their preferences for friends and team partners may change.

For example, gender homophily declines as children age (McMillan, 2022), so there might be more cross-gender friendships and collaborative ties in older students. Therefore, future research should seek to replicate the findings for different age groups.

Second, peer perceptions of physical ability could be biased. Even though peer perceptions of academic (Gest et al., 2008) and physical ability (Howle et al., 2016) correlate highly with teacher ratings, both teacher and peer perceptions might be biased by stereotypes. Studies have, for example, examined systematic biases in ability attribution against minority students, whereas gender did not systematically affect attributions (Grow et al., 2016). Perceptual biases regarding students' physical ability should also be investigated in PE, as stereotypes against girls, overweight and obese students and students with disabilities prevail (Metz et al., 2024).

Third, students' goals and motivation were not taken into account in the analyses. Whether students are motivated to win in a sports game or want to affiliate with their friends might have an important impact for choosing team partners. Future studies should therefore jointly analyze the effects of physical ability, gender and motivation to gain a deeper understanding of students' preferences for collaboration in PE.

Furthermore, the limitation to a maximum of five friendship and ten team partner nominations may have affected the results, as ceiling effects for students' outdegrees were observed. Future studies should allow students an unlimited number of nominations to eliminate potential biases.

Last, the cross-sectional design of the study limits the interpretation of the results. Neither causal nor temporal relationships between the identified variables could be inferred, referring to whether students like being on the same team because they are already friends or vice versa. Because physical ability plays a role both in friendship and team partner selection, its influence also cannot be clearly distinguished. Future research should examine the mechanisms between these characteristics longitudinally to disentangle these effects.

## Conclusion

This study shows that high physical ability is an important characteristic for being chosen as team partner in PE, and that high performing students especially emphasize nominating other high performers. Additionally, boys are preferred as team partners compared to girls, which

relates to them on average being perceived as higher performing. The findings show a strong social hierarchy based on physical ability that may negatively impact the long-term mental health and physical activity of low performing students. PE should therefore aim to promote peer relationships and the social acceptance of all students by reducing the emphasis on competition and working against gender stereotypes. Instead, PE should expand the notion of sports by including different perspectives of meaning and ability.

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## Supplementary Materials

Supplementary materials can be found at [LINK TK]

Physical Ability Group Receiver	High	38.7%	52.3%	69.7%	52.8%
		116/300	670/1281	198/284	984/1865
	Moderate	28.1%	32.1%	29.9%	31.1%
		309/1098	1477/4602	383/1281	2169/6981
	Low	23.3%	13.6%	8.3%	13.9%
		49/210	149/1098	25/300	223/1608
		Low	Moderate	High	Total
		Physical Ability Group Sender			