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Use of Sports as a Label in Google Scholar Profiles

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Author profiles in academic social media and database services are important research search, access, and promotion tools. This study documented the use and relevance of sports as research interest areas using the "label" function in Google Scholar Profiles. Profiles and citation metrics for the top twenty Google Scholar Citations Profiles were extracted for 22 sports and four sport terms. Citations to the top twenty profiles for each term were classified as relevant to that sport research interest label if there were at least four publications on that sport. The number of profiles using any of the 22 sport terms varied widely (*CV* = 122%), ranging from 22 for fencing to 549 for football/soccer. The mean (*SD*) relevant profiles across sports were 40 (17) percent and less variable (*CV* = 43%) than the citation metrics. There were moderate to strong associations in five of the six pairwise correlations. Several results indicate that use of specific sports as research areas with the label function to search Google Scholar Profiles should be interpreted cautiously. Many profiles using a sport as a label may not be related to the majority of highly cited publications on that sport. The number of profiles and citations to profiles related to sport keywords support previous research reporting large variation in citations using common kinesiology subdisciplines and research terms as labels for searches of Google Scholar Citations.

Keywords: author profile, bibliometrics, research focus, sport, subject area

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Academic publishing and indexing have transitioned almost completely to internet-based, online formats. This has increased the speed of bibliometric research, publication, and influenced how scholars work and promote their publications (Misra & Ravindran, 2022; Zhang & Li, 2020). Increasingly scholars are using author/researcher profiles within academic social media services like Academia.edu, ResearchGate, Open Researcher and Contributor ID [ORCID], university research management systems (Lee et al., 2022), or bibliometric database services like Google Scholar Citations, Scopus Author Identifier, and Web of Science Researcher ID (Kim & Grofman, 2020; Ortega, 2015b, 2017; Tetsworth et al., 2017). Author profiles assist with differentiating a scholar from others with similar names (Misra & Ravindran, 2022) and with the promotion of research, networking, and collaboration (Zhang & Li, 2020). Over the last decade, considerable research has reported differences in scholar usage of author profiles between disciplines and between different profile services (Alexi et al., 2024; Lee et al., 2022; Orduna-Malea & Delgado Lopez-Cozar, 2017; Ortega, 2015b, 2015a; Ortega & Aguillo, 2014; Tran & Lyon, 2017; Zhang & Li, 2020).

Research on the use of author profile services across disciplines usually focus on a few research subject areas using high-level disciplinary categories defined by databases (Ortega, 2015b, 2017; Ortega & Aguillo, 2014; Shtovba & Petrychko, 2021), so less is known about small and interdisciplinary subject areas like kinesiology. Initial research on author profile use of kinesiology scholars and kinesiology-related terms in bibliometric databases has been reported. Knudson (2022a) studied the top 20 Citations to kinesiology-related subdisciplinary keywords used as a "label" in Google Scholar Citations user's "Profile" feature [https://scholar.google.com/intl/en/scholar/citations.html]. Scholars with confirmed affiliations in kinesiology departments/schools contributed to most profiles, with only five of the 20 keywords and most top-cited scholars from other disciplines. A study of Google Scholar Profiles using several higher-level kinesiology disciplinary and professional terms as labels found wide variation in citations (Knudson, 2022b). Inconsistent use and citation of kinesiology-related terms in bibliometric and author profile services (Knudson, 2022b) pose a research visibility threat to kinesiology-related

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research and scholars (Knudson, 2019).

Scholars using the profile and label tools in Google Scholar Citations to search for research or network for collaborators will find top-cited articles with vastly different citation totals across these user-defined keywords for research interest. Terms used for Google Scholar labels like "physical activity" or "exercise" garner 5 times more citations than "sport" (Knudson, 2023), while "sport psychology" will receive 15 times more citations than "sports coaching" or "sport sociology" (Knudson, 2022a). Using keywords with the "label" function in a Google Scholar Profile provides the advantages of author and discipline-specific terms and knowledge about that area of scholarship (Ortega & Aguillo, 2012). The disadvantages of unrestricted use of keywords as research labels are inconsistency in specificity and relevance of terms and their alignment with various subject categories assigned by bibliometric databases (Wahid & Mustafa, 2024). In kinesiology, for example, none of the top 20 Google Scholar Profiles using the "measurement" label were affiliated with kinesiology departments.

In contrast, 100% were affiliated with the labels "physical education" and "sport(s)_philosophy" (Knudson, 2022a). This study extended the initial studies of Google Scholar Profiles of kinesiology-related terms used as research interest areas by documenting the number of profiles using sport terms, their potentially relevant use by scholars as a research interest label, and the citations to top profiles. These data are important in understanding scholar interest in specific sports and the accuracy and consistency of use of these terms as key areas of a scholar's research agenda in their Google Scholar Profile.

Method

The *Profiles* feature within the Google Scholar Citations was used to study scholars' use of sport terms in describing their research areas of interest. Specifically, their use of sport terms using the *label* feature was a study focus. Google Scholar Profiles allow registered users to select up to five keywords or phrases as labels for their author profile. People with a Google Scholar Profile can correct/curate their indexed records, track citations, and network with other scholars. Google Scholar was used in this study because it provides the most comprehensive coverage of scholarly publications of all bibliometric database services (Delgado-Lopez-Cozar & Cabezas-Clavijo, 2013; Gusenbauer, 2019; Halevi et al., 2017; Harzing & Alakanagas, 2016; Martin-Martin et al., 2018, 2021; Meho & Yang, 2007). Google Scholar Profiles is also one of the more widely used author profiling services across disciplines (Ortega, 2017; Ortega & Aguillo, 2014; Zhang & Li, 2020).

A list of 40 common sports with worldwide participation was used to search Google Scholar Profiles. A typical search would be *label:field_hockey* or *label:golf*. The investigator searched and manually recorded the number of Google Scholar Profiles using each term by advancing the search results until the last profile was found. Following documentation on the number of profiles, the study collected additional data on the sports with at least 20 profiles using a sport as a label. Multiple versions of sport names (e.g., *hockey* and *ice_hockey*; *football* and *soccer*; *climbing* and *bouldering*) were also used to ensure that most all profiles intending to use the sport term in the English language as a label for research interest and with 20 or more profiles were documented. Data for sports combining synonymous or multiple terms for the same sport were merged and ranked by total author citations. In addition, searches of four additional sport terms (*sport*, *sport_coaching*, *sports_analytics*, and *sports_coaching*) were made for comparison to a previous study (Knudson, 2022a). These terms represented both long-term and recent areas of research interest and used both forms (*sport* and *sports*) that have different uses worldwide (Knudson, 2022a). The sport terms (n = 22) included in the study and additional comparison terms are presented in Table 1. Some examples of excluded sports with many profiles found were *American_Football*–3, *Archery*–11, *Field_Hockey*–6, *Lacrosse*–1, *Pickleball*–3, *Racquetball*–0, *Softball*–6, and *Table_Tennis*–19.

Citations for the 20 most cited articles of the top 20 Google Scholar Profiles for each included sport term were entered into an Excel spreadsheet. The investigator reviewed all the top 20 cited publications for each of the top 20 cited scholars for each sport/term(s). When top-cited scholar profiles were outside English, the Google Translate function checked publication titles. Scholars' profiles were deemed related to their purported sport label as a research focus if at least four (20%) of their top 20 cited publications included that specific sport. Twenty percent was deemed a reasonable number of highly cited publications indicative of a true research interest in a specific sport rather than a personal interest that would not have any or only a couple of publications unrelated to their scholarly agenda. Spreadsheet cells were identified as included or excluded data for sport-specific analysis of citations. Scholars can have several research foci, but four peer-reviewed publications on that topic were deemed necessary to count as research expertise/specialization, not just a personal interest or a few outlier studies on a sport. It was common to have highly cited scholars with no research specific to the sport they used as a Google Scholar Profile label. These scholars may use this label and the *alerts* tool of Google Scholar Citations to keep them informed on research on a sport of personal passion rather than scholarly research.

The four dependent variables examined in this study were: (1) Total Google Scholar Profiles (*Total GSP*), (2) Percentage Relevant Top 20 Profiles (*%Rel T20*), (3) Total Citations to Top 20 Profiles (*Tot CT20*), and (4) Mean Citations per Relevant Top 20 Profiles (*MC/RT20*) for the 22 sport and 4 sport comparison terms. Based on a previous study, the manually

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extracted and checked raw Google Scholar citation data errors were likely less than 1% (Knudson, 2023). This study also compared the reliability of the *%Rel T20* to the relevant percentage found for all the profiles of two randomly selected sports (*Cricket* n = 60 & *Tennis* n = 100). This analysis indicated that the reliability of the *%Rel T20* would likely be within 3 to 8 percentage points of the population of all profiles using that sport label. All searches were completed over several weeks, and data were rechecked for final analysis by May 14, 2024. Google Scholar data are updated twice a week and are not archived and linked to specific years like curated databases, so the study data are accurate as of May 14, 2024.

Data were imported and analyzed with *JMP® Pro 15.1.0* (SAS Institute, Cary, NC) software. Descriptive data reported included the mean, standard deviation (*SD*), coefficient of variation (*CV*), and median, given that the data had positive skews (γ = 0.89 to 3.44). Only the *%Rel T20* variable with the skew of 0.89 tested normal ($W = 0.93$, $p = .112$). Kendall's Tau was used to determine the associations between variables for the 22 sport terms because the skew resulted in most all plots with heteroscedasticity and outliers (Croux & Dehon, 2010). The type I error rate for statistical tests was set at $p < .05$, and significant associations were converted to Pearson r (Walker, 2003) to ease interpretation. Strengths of associations were interpreted as *weak/low* (± 0.30–0.49), *moderate* (± 0.50–0.69), *strong/high* (± 0.70–0.89), or *very strong/high* (± 0.90–1.0).

Results

Total GSP using the 22 sport terms varied widely (*CV* = 122%), ranging from 22 for *fencing* to 549 for *football/soccer* (see Tables 1 & 2). The most general comparison term, *sport*, had almost three times as many profiles as *football/soccer*. The more specific comparison terms (*sports_analytics*, *sports_coaching*, and *sport_coaching*) had Total GSP values generally similar to those of the 22 specific sports.

Most of the use of sport terms as a Google Scholar Citations research interest *label* was irrelevant based on the study standard of at least four top 20 cited publications on that sport. Only five of the 22 sports used as a research label had over a majority (*%Rel T20* > 50%) of relevant use of the sport terms examined. *Mean* (*SD*) *%Rel T20* was 40 (17) percent with moderate relative variability (*CV* = 45%). However, *Tot CT20* and *MC/RT20* varied widely, with 125% and 126% *CV*s, respectively.

Discussion

Novel results of this study include specific sport terms used as a *label* to specify research interest areas in scholars' profiles within Google Scholar Citations; these terms are likely relevant as an actual area of scholarly focus, and variation in citation patterns in these sports-related keywords. There was a large (almost 24 times) variation in scholars' use of one of 22 sport terms in their author profile, from 22 for *fencing* and 23 for *skiing* to 549 for *football/soccer*. There is no way to know the number of sport and kinesiology scientists worldwide. However, the relatively low numbers of *Total GSP* for these sports terms, given the likely many thousands of sport science researchers, is consistent with previous research reporting low percentages of scholars using author profile services (Ortega, 2015a; Ortega & Aguillo, 2014; Roszkowski, 2020; Tran & Lyon, 2017). Despite this likely low percentage of scholars reflected in the *Total GSP* in this study, there was a 44% and 51% increase in *Total GSP* for the comparison searches of *sports_analytics* and *sports_coaching* from the total reported for these terms two years ago (Knudson, 2022a). The larger number of profiles (124) using the label *sport_coaching* over *sports_coaching* is also consistent with previous research reporting the inconsistent use of the multiple plural forms of *sport* and *sports* throughout the world (Knudson, 2022a; Starosta & Petryuski, 2007). Inspection of *Total GSP* across sports supports the inference that using sport terms as research subject areas in Google Scholar Profiles may not follow the pattern of sport popularity or participation worldwide. The current study's high and low participation sports had low and high *Total GSP* numbers.

This study may be the first to explore the relevance of scholar specification of research interest using the Google Scholar Profile *label* function. Since the implementation of *Profiles* within Google Scholar Citations in 2011, there have been no controls over the use of label terms other than a limit of five per author profile [Ortega and Aguillo (2012); https://scholar.google.com/intl/en/scholar/citations.html]. Many scholars likely use the *label* and *alerts* functions of Google Scholar not to specify a major area of research work but a personal interest in a sport. The moderate (r = .26) positive association between *Total GSP* and *%Rel T20* supports the interpretation that no meaningful differences exist in the relevant use of research labels across sport popularity. People searching Google Scholar Profiles using sport terms as *labels* for scientific publications should expect a minority of the top-cited researchers to have a consistent research agenda aligned with those terms. While the reliability data indicate that *%Rel T20* is likely similar to the percentage for all profiles using that term, future research should confirm this hypothesis using several common kinesiology-related terms as labels.

While there was moderate variation (*CV* = 43%) of *%Rel T20* across sports, the *Total GSP*, citations, and citation rates were more variable (*CV* = 122% to 126%). There were moderate to strong (r = .26 to .75) positive associations between *Total GSP* and the three Google Scholar citation variables. The percentage of the relevant top-cited profiles (*%Rel T20*) was also moderately positively associated (r = .41) with the *Tot CT20* but not the average citations (*MC/RT20*) for the 22 sport terms. Together, these results and associations indicate

Table 1: *Descriptive Data for the Top 20 Google Scholar Profiles (GSP) Using Sport Labels*

Label	GSP	%Rel T20	CT20	MCR
Athletcis	100	75	33,810	2,254
Badminton	62	20	3,806	772
Baseball	34	40	13,176	1,647
Basketball	140	55	50,475	4,589
Boxing	24	25	1,604	321
Climbing/Bouldering	28	25	2,767	553
Cricket	60	60	7,735	1,289
Cycling	149	30	44,917	7,486
Fencing	22	25	219	44
Soccer	549	35	91,552	13,079
Golf	48	15	3,640	1,213
Gymnastics	79	60	12,991	1,083
Handball	69	45	5,749	639
Hockey/Ice Hockey	28	25	492	98
Rowing	31	45	7,183	798
Rugby	50	40	23,354	2,919
Running	129	55	102,024	9,275
Skiing	23	30	5,771	961
Swimming	189	40	32,799	4,100
Tennis	102	45	30,295	3,362
Volleyball	104	80	19,573	1,223
Wrestling	25	40	3,231	404
Median	61	40	10,363	1,218
Mean	93	40	22,564	2,641
SD	113	17	28,269	3,339

Note. GSP = Total Google Scholar Profiles; %Rel T20 = Percentage Relevant Top 20; CT20 = Total Citations to Top 20 Profiles; MC/RT20 = Mean Citations per Relevant Top 20 Profiles. Searches completed May 14, 2024.

Table 2: *Comparison Sport Terms*

Label	GSP	%Rel T20	CT20	MCR
Sport	>1,480	65	309,286	23,791
Sports_Analitics	239	10	20,523	10,262
Sports_Coaching	74	45	30,086	3,343
Sport_Coaching	124	65	47,526	2,376

Note. Comparison of Total Google Scholar Profiles (GSP) Using Sport Terms; %Rel T20 = Percentage Relevant Top 20; CT20 = Total Citations to Top 20 Profiles; MCR = Mean Citations per Relevant Top 20 Profiles.

Table 3: *Correlation (r) Matrix for Kinesiology-Related Journal Metrics Calculated from Kendall's Tau*

	%Rel T20	CT20	MCR
GSP	0.515*	0.867*	0.867*
%Rel T20		0.643*	0.452
CT20			0.976*

Note. Associations statistically significant ($p < .05$)*. Kendall's τ values were converted to correlation coefficients r (Walker, 2003).

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that Google Scholar users should not consider total citations to a specific scholar's Google Scholar Profile, given a specific sport of interest as a label, as likely research productivity on that sport. The wide variation in scholars' use of GSP (*Total GSP*) and the minority of scholars with relevant profiles (*%Rel T20*) indicate partial specificity of this strategy. Multiple and careful searching of the whole Google Scholar service and other databases is a superior strategy to identify all relevant sport research or scholar expertise (Gusenbauer & Haddaway, 2020; Knudson, 2022b; Vaughan & Thelwall, 2004).

The limitations of this study include the 40 specific sports terms that were searched for and the one-time running snapshot of citation data provided by Google Scholar Citations. The relevance of sports keywords as labels varies due to the inconsistency of keyword use by scholars using GSP and the 20% standard sport alignment standard in this study.

Conclusion

Use of specific sports as research areas using the *label* function to search Google Scholar Profiles should be interpreted with caution. Many profiles using a sport as a label may not be related to many highly cited publications on that sport. The number of profiles and citations to profiles related to sport keywords support previous research reporting large variation in citations using common kinesiology subdisciplines and research terms as labels for searches of Google Scholar Citations.

License

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Changing Language and University Students' Exercise Motivations

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Typically, and without a pandemic, one-quarter of adults do not get appropriate physical activity. Amid government restrictions and public gathering closures associated with the COVID-19 pandemic, this study's objective sought to understand motivations for physical activity among university students. Participants of 147 undergraduate (n = 102) and graduate (n = 45), including most females (n = 118), completed the Rickel Value Inventory (RVI), which consisted of seventeen Likert-scale inventory questions and a ranking of top motivators for participation in physical activity. The results indicated that during the COVID-19 pandemic, participants preferred objective or extrinsic motivators for engaging in physical activity, such as weight management and maintaining physical health, than subjective or intrinsic motivators associated with self-fulfillment. University sports managers and physical activity leaders should incorporate language reflective of objective/extrinsic in addition to subjective/intrinsic motivation and methods in advertising, teaching, and scheduling to increase and maintain exercise motivation and adherence.

Keywords: exercise, intrinsic, extrinsic, motivation, college

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The benefits of regular participation in physical activity (PA) by adults have been shown to prevent and manage non-communicable diseases (NCD) in a multitude of ways, such as improved cardiovascular fitness, mental health, and cognitive function in addition to reducing arthritis symptoms, risk of high blood pressure, and weight gain (World Health Organization, 2022). The benefits of PA participation for healthy aging are equally compelling—improved sleep, balance, and joint mobility; reduced risk of falling in addition to delayed onset of cognitive decline, weak bones, and muscle loss, according to the Center for Disease Control and Prevention (Center for Disease Control and Prevention, 2022). These benefits have been accepted worldwide, as exemplified by World Health Organization (2022)'s recognition that physical activity is a global issue that needs to be addressed as a health topic. Similarly, in the United States, Center for Disease Control and Prevention (2022) has listed positive results related to PA for children, adults, and healthy aging. The impact of regular participation in PA goes beyond physical health. It can be viewed as a component of overall health and wellness, including social, emotional, intellectual, spiritual, and environmental health (Donatelle, 2019). Engagement in PA impacts and extends into individuals' psychological health and has been shown to positively affect mood and mental and social health (Glowacki & Faulkner, 2019; Lathia et al., 2017; Yzer & Gilasevitch, 2018).

The list of benefits and risk reductions of NCD from participating in PA is also coupled with the economic benefits to communities and countries. Annual medical costs of obesity associated with less than the recommended PA in the US were close to $173 billion (about $530 per person in the US). Physically active people are more productive and use fewer sick days (Center for Disease Control and Prevention, 2019). Overall, a healthier individual, community, and economy are the products of regular PA participation by costing less in

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medical issues and increasing productivity.

Recommendations and Reality

Center for Disease Control and Prevention (2019) and World Health Organization (2022) advocate for PA to include all types of movement, extending beyond traditional activities such as walking, cycling, running, rolling, and dancing. They emphasize that PA is optimal for all aptitude and skill levels. According to both organizations, adults aged 18–64 should achieve at least 150 minutes a week of moderate-intensity activity, such as brisk walking, and at least two days of strengthening muscle activities, such as weight training (Center for Disease Control and Prevention, 2019; World Health Organization, 2022).

Globally, the current estimate is that 25% of adults and 81% of adolescents aged 11–17 do not achieve appropriate physical activity (World Health Organization, 2022). In the United States, the statistics are that 75% of adults and 80% of high school students do not achieve the level of activity recommended for chronic disease prevention, such as heart disease, colorectal cancer, and diabetes: the latter of which about one in two adults have a chronic disease (Center for Disease Control and Prevention, 2022). As the numbers indicate, once people enter their young adult and college years, they are at a lower level of achievement in terms of physical activity participation. According to American College Health Association (2022), in the Spring of 2022, 69% of college students met the recommended levels for aerobic activity minutes in a week (150 moderate or 75 vigorous intensity). Only 43% met the aerobic guidelines and included two or more days of strength training (American College Health Association, 2022). This data is within the five percent range of the Fall 2020 participation and overall representative of collegiate physical activity participation dating back to Fall 2019 of 67% aerobic exercise only and 40% of students additionally engaging in two days of strength training (American College Health Association, 2022). Based on these statistics, more PA participation among college students is needed. Researchers and practitioners are well-positioned to understand and implement strategies encouraging college students to increase physical activity and maintain such levels as they enter adulthood.

Motivation

The motivation to participate in physical activity has been a research topic in many strands, from adherence to specific age groups. While creating the Exercise and Depression Toolkit, it was found that adults with depression experienced a lack of motivation, fatigue, and low mood when not exercising (Glowacki & Faulkner, 2019). What contributed to an increase in PA engagement were the attitudes of others, receiving emotional support, and ongoing support for the exercise itself. This relates directly to one's overall psychological health as part of the dimensions of wellness to include social health, which can serve to allow participants to relate to one another and draw support for motivation by shifting their thinking (mental health) to improve their emotional health (feeling), thus their ability to exercise or engage in PA and overall being (spiritual health) by an improved sense of peace, purpose, and connections (Donatelle, 2019).

Research examining the distinction between subjective and objective motivation has found that the more intrinsically motivated a person is, the more frequently they will engage in physical education and activity (Lulescu, 2020). Subjective factors include the perception of fun, personal challenge, and personal affiliation. At the same time, objective motivation focuses on outside factors and a reward, including health and weight, physical appearance, and pleasing others such as friends. Previous studies found a relationship between sport and friendship developed during middle adolescence and noticed this relationship dropped during late adolescence (Boiché et al., 2015). Additionally, as students became busier with school and their classes, their sports involvement decreased, impacting multiple health dimensions, including physical and social wellness.

One study found that university students preferred exercise to reduce stress, in addition to recognizing time constraints as a common barrier to exercise and seeking help for depression (Yzer & Gilasevitch, 2018). However, when surveyed on their beliefs about exercise, students listed getting fit as the most common advantage. The main distinctions from the study were the beliefs between exercise and help-seeking for depression and time constraints being a barrier for both exercise and help-seeking for depression. The preference for objective motivators for PA found in the present study gives insight into a general view of PA and is consistent with prior research.

High School to College Transition

When comparing motivation and PA levels between high school and university students, high school students reported more PA than university students (Sevil et al., 2018). The research suggests there could be an association with university students experiencing a big life transition, no required physical education classes, increased independence with decreased time, and lack of information and encouragement on how to fit PA into their new lives. The study also found a relationship between high school students and increased subjective motivation for PA and lower levels of amotivation (lack of motivation) compared to university students. A survey of first-year university students found changes in patterns, preferences, and motivation (Wilson et al., 2021).

Researchers have found that many factors determine exercise adherence, including time constraints, lack of motivation, fatigue, low mood for those diagnosed with depression, and lack of structured PA time for university students

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(Boiché et al., 2015; Glowacki & Faulkner, 2019; Yzer & Gilasevitch, 2018). Some research focused on understanding the different motivators, while others focused on what contributes to lack of involvement. The recurring themes for exercise adherence are the type of motivation (internal/subjective or external/objective), time constraints, and fatigue. Other researchers agreed and found that PA had a positive impact on reducing stress in college students and suggested that students should find ways to engage in PA (Meyer & Larson, 2018). Data show that exercise and PA are beneficial for us. Although there are barriers to engaging in exercise, we must continue to find ways to participate.

Exercise and COVID-19

In late 2019, COVID-19 entered the world and continued into 2022. The impact of the pandemic on our global population, as of early March 2021, resulted in more than 2.4 million deaths and 112 million confirmed cases worldwide, with 500 thousand deaths and 28 thousand confirmed cases in the US to date (World Health Organization, 2023). The recommendations and guidelines by the CDC to reduce and stop the spread of COVID-19 caused many to self-isolate and physically distance themselves, leading to the cancellation or closure of many fitness centers, parks, and recreation opportunities. During the spring and summer of 2020 in the US, people were discouraged from being outside and asked or mandated to stay home to varying extents. Due to the lack of in-depth knowledge and reality of this novel virus and how precisely contagious COVID-19 was, states and cities enacted differing restrictions such as the California Coronavirus Response (California All, 2021) and Washington State Department of Health (Washington State Department of Health, 2021) instructions for residents to stay home. As a result of such necessary precautions to slow the spread of this novel disease, people relied on their motivation and creativity to find ways to engage in PA.

Researchers analyzed data from more than 47,000 college students around the country and found that 65% of students reported that COVID-19 impacted their mental health, and 61% reported that it impacted their motivation or focus (Penn State University, 2021). According to data from the NPD Group (Guyduy, 2020), compared to sales from 2019, adult leisure bike sales increased 121%, free weight sales increased 181%, and yoga mat sales increased 146%. With the increase in sales of home exercise equipment, it became clear that COVID-19 affected how people approached and achieved the recommendations for PA.

The COVID-19 pandemic and the associated changes (e.g., shelter-in-place and other restrictions) have created a gap in the literature on exercise and PA, which the current research aimed to begin addressing. A better understanding of current motivations may assist university communities such as exercise and sports programmers, health centers, student life, and faculty and administrators in meeting the needs of students in the best manner during this unprecedented time.

Method

Participants

Participants were asked to provide information regarding their gender, grade level, college major, and age. Though the central goal of this research was not to distinguish differences between demographic categories on motivation to exercise during the COVID-19 pandemic, these data allowed researchers to better understand the survey participants. With detailed demographic information, the researchers provide additional context during the discussion of the findings.

Procedure

To analyze motivations for physical activity during the COVID-19 pandemic, the current research targeted university students at a private university located in the Pacific Northwest region of the United States. Once institutional review board approval was obtained, the research team posted an announcement to participate in the survey through the university's morning email bulletin from early September 2020 through early October 2020. The email was sent to all undergraduate and graduate students, and approximately 7,500 students at the university had an opportunity to participate. The message contained an explanation of the research study, a disclaimer concerning voluntary participation and anonymity, and a link to the survey hosted on Qualtrics. Upon following the link, participants were directed to a consent form followed by the survey.

The university policies from March 2020 were to stay home when possible, shift to remote classes and events, and cancel in-person activities. In Fall 2020, the university offered a mix of hybrid, virtual, and in-person classes depending on the nature of the course (labs, or lecture), and intramural sports and other outdoor activities were not available. At the time of the survey, students had not been on campus from March 2020 to August 2020, with most students not returning to campus from August 2020 to December 2020. During this time, it is unknown what the local government restrictions were for each of the students' hometowns (e.g., (California All, 2021); (Washington State Department of Health, 2021); (World Health Organization, 2023)). In addition to COVID-19, in Fall 2020, the US West Coast experienced wildfires, adding another barrier for students to be outside because of dangerous air quality.

Motivation

Motivation to exercise during the COVID-19 pandemic was measured using the Rickel Value Inventory (RVI), which was developed to assess objective (i.e., extrinsic) and subjective (i.e., intrinsic) motivations to exercise, and it has been

utilized in multiple contexts (e.g., (Foster, 2022); (Gao et al., 2014); (Garrison et al., 2014); (Hasey et al., 2007); (Rickel et al., 2005)).

The tool is an 18-item Likert-scale inventory consisting of 11 objective and seven subjective statements. Participants were asked to state how much they agreed with the given statement regarding how they viewed and felt about exercise, PA, or play. The level of agreement with each of the 18 items was gauged by a five-point scale ranging from 5 (Great) to 1 (None).

The survey results showed good internal consistency for both the objective (11 items) and the subjective (7 items) motivations (Cronbach alphas objective .86; subjective .79). Sample items included "During the pandemic, I exercise, physically play, or move to control my weight" (objective) and "During the pandemic, I look forward to exercise, physical play, or movement activity" (subjective).

In addition to completing the standard RVI, participants were asked to rank their top three items (i.e., motivations) from the 18 statements, regardless of whether objective or subjective. By establishing a ranking, the researchers were then able to determine the most important singular motivations to exercise during the COVID-19 pandemic to these students.

Common Method Variance

Procedurally, as suggested by (Liu et al., 2017), common method variance was addressed in several ways. To promote response truthfulness, participants were assured of the confidentiality and anonymity of the study. To reduce discomfort or anxiety, the study explanation conveyed the nonexistence of "right" and "wrong" survey answers. Finally, survey items were displayed linearly to emphasize separation and encourage careful reading of each item (Podsakoff et al., 2003).

Data Analysis

Once data were collected, the first step was to compile and analyze descriptive statistics representing various groups of participants and their survey responses. This analysis was followed by a nonparametric Sign Test to check whether objective and subjective motivations, paired by survey participants, differed in the sample. The Sign Test was chosen for this analysis due to the presence of ordinal data (i.e., non-normal distribution) and the violation of the assumption of a symmetrically shaped distribution of differences that must be satisfied for more powerful nonparametric methods (e.g., Wilcoxon Signed Rank; (Krzywinski & Altman, 2014)).

The final analysis addressed participants' top-three rankings of individual survey items. Like the methodology behind a poll ranking American college football teams (e.g., Associated Press Poll), participants provided their top three items that motivated them to exercise. The items ranked first were awarded three points, the items ranked second were awarded two points, and the items ranked third were awarded one point. After all points were assigned, totals were compiled for each item, and a ranked-order list was created ranging from the most points (i.e., highest ranked motivator) to least points (e.g., lowest ranked motivator).

Table 1: *Participant Demographics*

Gender	**N (%)**
Male	25 (16.7)
Female	118 (78.7)
Non-Binary	4 (2.6)
Age	**N (%)**
18–24	114 (76.0)
25–30	15 (10.0)
31–44	8 (5.3)
45+	10 (6.7)
Class Standing	**N (%)**
First-year student	21 (14.0)
Sophomore	18 (12.0)
Junior	29 (19.3)
Senior	34 (22.7)
Graduate	45 (30.0)

Note. n = 150; three participants did not complete demographic questions.

Results

After four weeks of data collection, the sample comprised 150 participants who completed the RVI. Of these, 147 completed the demographic questions, 78.7% of whom were female. These participants primarily fell in the 18–24 age range (76.0%) and were distributed evenly across all college class levels (first-year student to Graduate) and nine categories of college majors. Table 1 provides demographic frequency breakdowns for all four categories.

The RVI survey items explored subjective and objective motivations for exercise, with Q1–Q10 representing the objective component and Q11–Q17 comprising the subjective component. In comparison of the objective and subjective components, the objective component was shown to be a significantly higher-ranked motivator than the subjective according to the nonparametric sign test that was conducted. The participant frequencies, which show the relative ranking of objective versus subjective, are displayed in Table 2. The results show the participants' preferences for objective as compared to subjective. The resulting nonparametric sign test of related samples can be seen in Table 3.

Finally, the individual rankings of each motivator are presented in Table 4, showing a greater number of objective mo-

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Table 2: *Frequencies of Objective and Subjective Motivation Comparisons*

Objective – Subjective	N
Positive Differences[a]	61
Negative Differences[b]	20
Ties[c]	69
Total	150

Note. [a] Objective > Subjective. [b] Objective < Subjective. [c] Objective = Subjective.

Table 3: *Results of Related Samples Sign Test*

Measure	Value
Total *N*	150
Test Statistic	20.0
Standard Error	4.50
Standardized Test Statistic	-4.44
Asymptotic Sig. (2-sided test)	<.001*

Note. Significance level: .001.

tivators appearing at the top of the list than subjective motivators. This distribution aligns with the objective mean of 2.8, in contrast to the subjective mean of 2.5.

Discussion

The present study contributes to the current literature surrounding university students' motivation for exercise, physical play, and/or movement during the COVID-19 pandemic, exploring objective motivation versus subjective motivation using the RVI (Rickel et al., 2006). Knowing that people's motivation to engage in PA can vary throughout life, it is important to understand how impactful one's access to PA opportunities is while addressing the varying components of motivation subjectively and objectively. Exploring the barriers to PA can provide a foundation for future studies to understand how to change the language around PA. Research tells us that college students who do not engage in PA have poorer mental health and poor social adaptability (Honghai & Changliang, 2021), which were impacted by COVID-19 and the associated distancing and quarantine restrictions. Social wellness or networks contribute directly to one's overall well-being and potential to continue to develop and rely upon their motivation, as exemplified by students' ranking of variations of socialization as number five and six in the RVI.

With the present study's findings that students' objective (extrinsic) component was significantly more of a motivation for exercise during COVID-19 (as determined by Tables 2 and 3), we can see the negative impact of low exercise and movement on mental health. A survey of 2,086 college students by Active Minds found that 80% of students felt COVID-19 negatively impacted their mental health, and the most impacted was their stress or anxiety, with 91%, followed by 81% of them having disappointment or sadness. Additionally, 73% of these students struggled to get enough physical activity. Data from the Fall 2020 survey provided comparable results in that 56% of college students reported their daily PA had decreased, and 89% felt stress or anxiety because of COVID-19 (Active Minds, 2020). In our ranked order list (Table 4), the highest-rated items were all objective (extrinsic): #1, #4, and

Table 4: *Rank Order of RVI Questions During COVID-19*

#	Question Detail
1	I exercise, physically play, or move for physical fitness and/or health.
4	I exercise, physically play, or move to maintain or improve my figure.
2	I exercise, physically play, or move to control my weight.
12	During the pandemic, I look forward to exercise, physical play, or movement activity.
6	Socialization is important in my exercise, physical play, or movement program.
8	I have a planned daily time for exercise, physical play, or movement activity.
10	I am more motivated with an instructor or another person to stay on task in exercise, physical play, or movement activity.
7	I incorporate exercise, physical play, or movement into my day.
16	I lose myself in exercise, physical play, or movement activities, not knowing time and space.
9	I am committed to exercise, physically play, or move without letting work, school, or other activities cancel my plans.
15	I intentionally create rhythmic patterns during exercise, physical play, or movement activities.
3	I exercise, physically play, or move to delay aging.
5	I exercise, physically play, or move to meet new people or socialize with others.
13	I define my day by my exercise, physical play, or movement activities.
11	I define who I am by my exercise, physical play, or movement activity.
17	When I watch movement, dance, or physical play on television, I am inspired to try the activity.
14	I dream about exercise, physical play, or movement activity.

Note. n = 140.

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#2. The highest-rated subjective (intrinsic) item was #12 (4th place overall). Our findings show that students' reliance on objective motivation during COVID-19, students' PA being lower than pre-COVID-19 times, and having increased anxiety and depression aligns with previous studies. While the cause is not specified, students may have had limitations to exercise due to COVID-19 restrictions or lack of motivation to meet their objective motivators, such as improving their figure and less concern with weight management during lockdown.

The University of North Carolina's (UNC) Exercise Is Medicine® on Campus found that staff who maintained relationships and consultations with students virtually during COVID-19 improved students' follow-up appointments surrounding PA, and students felt school leaders could have more mental health resources, including coping resources (Stanford et al., 2020). During COVID, college students showed they were less active and that they experienced poorer mental health; by enhancing their subjective motivation toward PA, students could have viewed PA as a coping resource to improve their mental health. As one's reliance upon objective motivators continues, they may find themselves lacking in specific areas of wellness, such as their ability to find enjoyment in engaging in PA for the sake of subjective factors such as learning a new skill (intellectual health), surrounding themselves in nature (environmental health), and recognizing their improved mindset and overall sense of achievement (spiritual health) (Donatelle, 2019). In situations where there is low external or objective motivation, individuals should be encouraged to activate or rely more upon their subjective motivation and understanding of the positive effects of PA on mental health to continue or participate, as UNC students indicated.

School leaders can encourage more subjective motivation by changing the language around PA to reframe students' views to reduce stress and create a sense and internal locus of control (Snyder et al., 2017) to accompany their objective motivation. Although COVID-19 has strongly impacted university students' PA adherence or participation, it remains of utmost importance that students understand they have the ability and must have a sense of ownership and internal locus of control over their capacity and mastery to engage in PA. In particular, understanding that university students utilize and prefer objective motivators (Tables 2 and 3), it is important to properly select and recognize extrinsic motivation and the potential for perpetuating harmful ways of thinking about why one engages in PA. Leaders can emphasize the positive impact of exercise on mental health and subjective motivation to inform programming at the collegiate level. By addressing students' subjective motivations, institutions can create initiatives that effectively engage and support students in maintaining their motivation for physical activity.

Conclusion

The current findings show the potential to shift the messaging and language around PA to increase students' and future practitioners' subjective motivation for PA. Researchers and practitioners recognize the importance of subjective motivation, yet how to shift participants to this side, particularly to supplement their objective motivation, is the ever-elusive question. Suppose we can increase participants' perception of PA's purpose and overall benefits through different approaches such as curriculum, the marketing of courses to match the challenges of unique needs of participants, and instructor cues and language around PA. In that case, their motivation may be influenced on the subjective side. Future research can investigate how teaching and using different languages around PA can impact motivation and which language shift is the most motivating.

In previous studies, researchers have supplemented participants' PA with brief readings on the philosophy of movement and play with short reflections to increase subjective motivation while maintaining objective motivation (Rickel et al., 2005). Other researchers found that increasing Physical Education teachers' skills in building student autonomy for PA increased students' motivation for PA (Abula et al., 2018). These findings showed promising results by increasing participants' subjective motivation in addition to their objective motivation. If instructors and sports professionals utilize language referring to the subjective side of exercise and PA, such as play and the benefits to their overall wellness (spiritual, emotional, social, intellectual) in addition to the physical and objective benefits, then participants see, hear, and feel this as acceptable and can model and embrace their approach to the subjective values articulated.

Sport management administrators and programmers are the front line in marketing, creating the class names, accessing such classes, and hiring the sports leaders in direct contact with participants. Administrators can consider using language similar to the instructors' to incorporate wellness benefits and market these classes as recess and playtime alongside the objective motivation language of workout and physical results such as calories burned. When creating these opportunities, the messaging and wording can emphasize both components of teaching about objective and subjective motivation to allow participants to call upon what they need at that time. People do not realize what they lack specifically in terms of motivation, and motivational needs vary depending on circumstances: hourly, daily, weekly, and beyond. Consider New Year's resolutions and how motivated people might be on January 1st versus February 14th. If people know what is missing, they can be taught to seek out different motivational cues to improve their subjective motivation and not rely strictly on one end of the motivation spectrum. Still, we must call upon both types of motivation to enhance and facilitate our continued participation in PA, even if it means utilizing

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differentiated teaching and instruction. Just as instructors and leaders are adapting and adopting more inclusive practices and language in the classroom, so should exercise and sport professional leaders and administrators adapt to the varied motivational needs of their clientele (Tomlinson, 2017).

Additionally, language and cues should speak to all genders to relate to all participants, particularly as they age and go through unique stages in life (Louw et al., 2012; Portela-Pino et al., 2019). The relationship between students' motivation for PA and objective motivators allows future researchers to explore how to educate students on PA's impact and enhance both types of motivation in addition to competence in the benefits of increased activity (Kwon et al., 2019). Transitioning from adolescence to young adulthood has many changes, including a lack of structured PA time for most. Implementing a course curriculum to increase motivation, specifically the subjective, and scheduling PA would be a beneficial avenue for additional research (Garrison et al., 2014; Sevil et al., 2018). Hence, it is important to recognize how language impacts how students view motivation, just as in coaching athletes and explaining actions to individuals. It is more effective to articulate desired behaviors explicitly rather than to focus on prohibitions. This approach conveys the same underlying message while employing more positive language, which can enhance comprehension and motivation.

Limitations

Limitations found were the low response rate from males, a limited collection of demographic information, contact with students, different COVID-19 restrictions in different geographic locations, and the survey being sent out during the West Coast's fire season. Male university students responded at a rate of 16.7% versus 78.7% from females. Without collecting ethnic demographic information with the RVI, but with the university's Integrated Postsecondary Education Data System Report page, we gather that 70% of the student population identifies as "white" and are not first-generation college students (Gonzaga University, 2019). Students were made aware of the study through an email bulletin; while it is accessible to all students, it is unknown how many students check their school email. Additionally, data from Qualtrics showed that many students stopped the survey after the study information sheet, which leads us to believe it was too long for students to read; halfway through data collection, we put the study information on an additional link for students to access, which gave us greater participation. The survey was open for students between mid-September and mid-October, when the West Coast experienced many wildfires and poor air quality, potentially reducing the number of people exercising outside. Lastly, with many students living at home in the Fall, it is unknown what their area's COVID-19 restrictions were, which may have prevented some from outdoor activities.

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The Coach-Athlete Relationship and NCAA Student-Athlete Satisfaction

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The quality of the coach-athlete relationship has a profound impact on athletes' experiences in sport. Although this topic has received increasing attention worldwide, few studies have investigated this phenomenon among NCAA student-athletes. The purpose of this non-experimental study was to determine if NCAA student-athlete perceptions of coach-athlete relationship quality had a predictive relationship with their ratings of athlete satisfaction. 387 NCAA student-athletes completed measures of coach-athlete relationship quality and athlete satisfaction. Respondents indicated generally positive perceptions of their relationship with their coach and reported moderately high satisfaction levels. The coach-athlete relationship was linked with athlete satisfaction, and regression analyses indicated that the quality of the relationship significantly predicted ratings of athlete satisfaction. Notable differences between sport types and competition levels provided evidence for context-driven approaches to enhancing the coach-athlete relationship. Results suggest that sports coaches, the NCAA, and coach education outlets may be able to enhance their athletes' sporting experiences by engaging in professional development aimed at fostering healthy relationship skills.

Keywords: coach-athlete dyad, coaching, interdependence, collegiate athlete, athlete satisfaction

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In the ever-changing climate of intercollegiate athletics, student-athletes continue to face unique obstacles (Brown et al., 2022; Gayles et al., 2018). As these individuals near the end of their high school careers, they look toward college as the next logical step in their development. Many factors, including location, academics, reputation, and cost, influence students' decisions when choosing a specific university. Unlike most senior high school students, however, college-bound student-athletes must consider an additional, and equally crucial, element when choosing which school to attend. That consideration is found in one of the most influential individuals in student-athletes' careers: their coach (Ayer, 2015).

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Throughout the recruiting process, student-athletes interact regularly with would-be coaches. Oftentimes, a decision to attend a college is based on the student-athletes' impressions of the coach (Garbert et al., 1999; Nixon et al., 2021). Put another way, the quality of the interpersonal relationship carries great weight in the student-athletes' decision. Moreover, the nature of the coach-athlete relationship may have a profound impact on the student-athlete throughout their career. Unfortunately, little is known about many aspects of the coach-athlete relationship in NCAA student-athletes and their effects on student-athlete satisfaction and well-being. This study aims to shed light on this knowledge gap.

The Coach-Athlete Relationship

Interactions between coaches and athletes are widely recognized as an important antecedent to both positive and negative sport outcomes (Choi et al., 2013; Jin et al., 2022; Jowett, 2003; Lafreniere et al., 2011; Poczwardowski et al., 2006). Moreover, the importance of the coach-athlete relationship has long been acknowledged at all levels of sport, from youth (Barnett et al., 1992) to elite international competition (Jowett & Cockerill, 2003). Due to its centrality in the athletic domain, this interpersonal dyad has garnered attention, as scholars have called for a more extensive analysis

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of the topic (Poczwardowski et al., 2006; Wylleman, 2000; Zhao & Jowett, 2023). For many athletes, the quality of the coach-athlete relationship characterizes their entire athletic experience (Poczwardowski et al., 2002). Not only does this interpersonal dimension affect performance outcomes, but it also influences several psychological processes (McGee & DeFreese, 2019; Simons & Bird, 2023). Indeed, the coach-athlete relationship has been considered the core element of coaching effectiveness (Jowett, 2017).

To better operationalize the coach-athlete relationship, Jowett and Poczwardowski (Jowett & Poczwardowski, 2007) broadly defined it "as a situation in which a coach's and an athlete's cognitions, feelings, and behaviors are mutually and causally interrelated" (p. 4). Scholars have documented the prevalence of each of these factors individually (Jowett, 2007) and in combination (Isoard-Gautheur et al., 2016) for both processes and outcomes of the partnership. Situational conditions may also affect the relationship (Gano-Overway et al., 2023; D. Rhind et al., 2012; Thelwell et al., 2017) along with other contextual factors (e.g., gender, competition level, sport type; (Foulds et al., 2019; Murray et al., 2018)).

Although several models exist (Jackson et al., 2009; Mageau & Vallerand, 2003; Moen & Federici, 2014), the most widely accepted framework for describing coach-athlete relationships is derived from interdependence theory. Jowett and Meek's (2000) conceptualization has evolved into the "3+1Cs" model, and includes dimensions of closeness, commitment, complementarity, and co-orientation (Jowett & Poczwardowski, 2007). Closeness is characterized by the affective elements (e.g., liking and trust) in the relationship. Commitment pertains to the coach's and athlete's intentions to maintain the partnership. The cooperative and responsive behaviors between individuals exemplify complementarity. Lastly, co-orientation is determined by collectively considering the direct perspectives (i.e., what one dyad member thinks, feels, and acts toward the other) and the meta-perspectives (i.e., what a coach or athlete believes the other dyad member thinks, feels, and acts) of the dyad members.

To assess these dimensions, instruments have been developed to measure both direct (Jowett & Ntoumanis, 2004) and meta-perspectives (Jowett, 2009) of the relationship. Indeed, the use of the "3+1Cs" framework is widespread, with links to self-determination theory (Choi et al., 2013), transformational leadership (Lopez de Subijana et al., 2021), and relational efficacy (Jackson et al., 2010). The Coach-Athlete Relationship Questionnaire (CART-Q; (Jowett & Ntoumanis, 2004)) appears to have cross-cultural validity in many international populations (Pinho et al., 2024; Wang et al., 2023; Yang & Jowett, 2012). Such widespread use confirms the universality of the coach-athlete relationship (Jowett et al., 2017) and its significance in sporting contexts.

Athlete Satisfaction

While performance outcomes represent the societal "measuring stick" of success in sport, an athlete's satisfaction should also be taken into consideration. It has been suggested that the ultimate effectiveness of an athletic organization should be based not on performance, but on the satisfaction of the athletes (H. Riemer & Chelladurai, 1998). Because competition results can be influenced by uncontrollable factors (e.g., officiating, opponents, luck), performance measures may not be as meaningful as more subjective perspectives. Aligned with this contention, the National Collegiate Athletic Association (NCAA) conducts the "Growth, Opportunities, Aspirations and Learning of Students (a.k.a., GOALS) study" every five years (National Collegiate Athletic Association, n.d.). Such an emphasis suggests that athlete satisfaction is as important as the sporting outcome, despite the societal emphasis on winning.

(Chelladurai & Riemer, 1997) defined athlete satisfaction as "a positive affective state resulting from a complex evaluation of the structures, processes, and outcomes associated with the athletic experience" (p. 135). These authors contend that athlete satisfaction should be a primary goal of college athletic departments and should be assessed on multiple dimensions. More specifically, athlete satisfaction can be categorized into both processes (i.e., day-to-day experiences) and outcomes (i.e., performance measures). Furthermore, the processes (e.g., the coach's leadership style) can directly affect ratings of satisfaction and also conjunctively lead to outcomes (e.g., winning), which naturally influence perceptions of contentment.

To assess athlete satisfaction, (H. Riemer & Chelladurai, 1998) created the Athlete Satisfaction Questionnaire (ASQ) for use with intercollegiate athletes. Despite the utility of this instrument, research on athlete satisfaction remains somewhat limited. Even still, coach leadership has been linked with athlete satisfaction (Jawoosh et al., 2022) as well as team cohesion and organizational citizenship behavior in NCAA student-athletes (Aoyagi et al., 2008). Moreover, the relational component between coach and athlete appears to be a unique contributor to athlete satisfaction (Beattie & Turner, 2022). Because satisfaction has long been associated with sport attrition (Eliasson & Johansson, 2021; Schmidt & Stein, 1991) and is also considered a prerequisite to peak performance (Karreman et al., 2009), the need is clear for a better understanding of its antecedents in general, as well as those specifically related to the coach-athlete relationship.

The Present Study

Few researchers have examined the perceptions of NCAA student-athletes regarding the relationship between coaches and student-athletes. This contextual factor represents a gap in the literature and, more importantly, if left unexamined,

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is a topic that could have negative implications for overall student-athlete satisfaction and well-being. Without a deeper understanding of the coach-athlete relationship, potential strategies for enhancing the quality of student-athlete experiences may be overlooked, to the detriment of future NCAA sport participants. Therefore, the purpose of this study was to determine if student-athlete perceptions of the quality of the coach-athlete relationship have a predictive relationship with their ratings of athlete satisfaction.

Method

Participants

The target population was all NCAA student-athletes in the United States. A cluster sampling technique was used to ensure adequate representation across divisions. At the time of data collection, there were 99 NCAA conferences (32 Division I, 24 Division II, 43 Division III). To ensure a representative sample of each division, 25% of the conferences in each division were randomly selected for inclusion. Then, one institution from each of these conferences (8 Division I, 6 Division II, and 11 Division III) was randomly selected for inclusion in the study, totalling 25 NCAA institutions. Of the total number of student-athletes at each of these institutions, 25% were randomly selected to receive an email with an informed consent form and an anonymous survey link. A total of 552 student-athletes responded to the survey out of the 2,233 who received the questionnaire, resulting in a 24.7% response rate. After removing incomplete data sets, 387 responses were fit for analysis. All data analyses were conducted with IBM® SPSS® 20.0 statistical software suite.

Measures

Coach-Athlete Relationship

The most widely used tool for examining this interpersonal dyad is the Coach-Athlete Relationship Questionnaire (CART-Q; (Jowett & Ntoumanis, 2004)). The psychometric properties of this instrument have been established for assessing both coaches' and athletes' perceptions of the relationship. In the present study, the athlete's direct and meta-perspective versions were used. Overall, this brief 11-item survey measures the quality of the coach-athlete relationship on three different constructs of interdependence: closeness (e.g., "I like my coach"), commitment (e.g., "I am close to my coach"), and complementarity (e.g., "When my coach coaches me, I am ready to do my best"). The response scale (Likert) for these measures ranges from 1 ("strongly disagree") to 7 ("strongly agree").

Athlete Satisfaction

The Athlete Satisfaction Questionnaire (ASQ; (H. Riemer & Chelladurai, 1998)) was designed to assess intercollegiate athlete perceptions of satisfaction on multiple dimensions. The ASQ consists of 56 items that assess important components of an athlete's experience in sport, including performance, leadership, the team, the organization, and the individual. The survey includes 15 different subscales that could affect an athlete's ratings of satisfaction including: individual performance, team performance, ability utilization, strategy, personal treatment, training and instruction, team task contribution, team social contribution, ethics, team integration, personal dedication, budget, medical personnel, academic support services, and external agents. Responses are rated on a Likert scale from 1 ("strongly disagree") to 7 ("strongly agree").

Procedures

Once IRB approval was obtained, participant emails were acquired through each institution's directory service on their respective university websites. In the instance that an institution did not have a public search directory, another school was randomly selected from the same conference. After student-athlete emails were collected, an electronic informed consent form, which included the survey link, was emailed to the randomly selected participants. The link led to a questionnaire built in Qualtrics® survey software. Participant names were not linked with their responses. After the initial survey was sent, reminders were given to each participant ten days after the initial email and then again twenty days after the initial contact.

Statistical Analysis

Descriptive statistics were conducted to determine the quality of the coach-athlete relationship and ratings of satisfaction. For the correlational analyses, the independent variables were perceptions of the quality of the coach-athlete relationship in terms of closeness, commitment, and complementarity. In contrast, the dependent variable was ratings of athlete satisfaction. Additionally, the three constructs of the CART-Q (i.e., the "3Cs") could collectively indicate a predictive relationship with athlete satisfaction. To determine the aggregate influence of these factors on ratings of athlete satisfaction (i.e., using the "3Cs" as multiple predictors), a standard multiple regression was used. Several examples of these correlational approaches are present in the coach-athlete relationship literature (Baker et al., 2003; Burns et al., 2012; Nicholls et al., 2016) to legitimize this rationale.

Independent sample *t*-tests were also conducted to examine any differences in responses to either the CART-Q or ASQ across gender and sport type (i.e., individual and team). A one-way ANOVA was completed to determine differences between competition level (i.e., NCAA division). When significant differences were noted in the ANOVA, a Tukey HSD post-hoc test was conducted to determine which groups differed. The alpha level was set at $p < 0.05$ for all analyses.

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Results

Responses to the direct perspective CART-Q resulted in an overall mean score of 5.69 (*SD* = 1.19). Within the 11-item questionnaire are three subscales including four Closeness items (e.g., "I like my coach;" "My coach likes me"), three Commitment items (e.g., "I am committed to my coach;" "My coach is committed to me"), and four Complementarity items (e.g., "When my coach coaches me, I adopt a friendly stance;" "My coach adopts a friendly stance"). Summary descriptive results for both direct- and meta-perspective subscales are shown in Table 1.

Table 1: *CART-Q direct and meta perspective scores*

Scale	*M*	*SD*
Direct – Overall	5.69	1.19
Direct – Closeness	5.86	1.25
Direct – Commitment	5.40	1.37
Direct – Complementarity	5.75	1.17
Meta – Overall	5.53	1.20
Meta – Closeness	5.66	1.25
Meta – Commitment	5.34	1.30
Meta – Complementarity	5.54	1.25

Note. N = 387. Responses were on a 7-point Likert scale (where 1 indicates poor coach-athlete relationship quality and 7 indicates good coach-athlete relationship quality).

For responses to the ASQ, the overall satisfaction rating of this sample was 5.09 (*SD* = 0.91). Although the overall rating of satisfaction is the primary variable of interest, the ASQ contains 15 subscales that were also analyzed. Participants in this sample reported the highest satisfaction with their Personal Dedication (*M* = 5.84, *SD* = 0.93). The subscale with the lowest rating was satisfaction with the team Budget (*M* = 4.05, *SD* = 1.68). A complete list of the ASQ subscale scores is found in Table 2.

Gender Differences

Mean scores for male and female participants were compared across both direct and meta perspectives of the CART-Q, including overall scores and the subscales of Closeness, Commitment, and Complementarity. Overall ratings from the ASQ were also analyzed within this subgroup. Males had higher mean scores than females on every scale of the CART-Q as well as a higher overall rating of satisfaction. However, none of these differences reached the $p < 0.05$ level of statistical significance (See Table 3).

Sport Type Differences

Overall and subscale scores on the CART-Q, as well as overall scores on the ASQ, were analyzed to identify differences between participants in team sports and individual sports. There were statistically significant differences between team sport and individual sport student-athletes on all measures, with individual sport participants reporting higher ratings on the ASQ and CART-Q instruments. Effect size was calculated using the formula for Cohen's d (Cohen, 1988). All effect sizes ranged from small to moderate based on Cohen's criteria (small effect size: d = 0.20, medium effect size: d = 0.50, large effect size: d = 0.80). The mean scores on the Complementarity subscale of the CART-Q meta-perspective had the largest effect size (d = 0.41) between the two groups. Complete results are shown in Table 4.

Table 2: *ASQ subscale scores (sorted in descending order of Means)*

Subscale	*M*	*SD*
Personal Dedication	5.84	0.93
Team Social Contribution	5.51	1.22
Ethics	5.51	1.10
Medical Personnel	5.45	1.41
Team Task Contribution	5.34	1.13
Team Integration	5.27	1.26
Personal Treatment	5.18	1.42
Academic Support Services	5.12	1.31
Ability Utilization	4.99	1.42
Strategy	4.97	1.41
Individual Performance	4.92	1.38
Team Performance	4.62	1.58
External Agents	4.41	1.39
Training and Instruction	4.14	1.44
Budget	4.05	1.68

Note. Responses were on a 7-point Likert Scale (where 1 indicates "Not at all Satisfied" and 7 indicates "Extremely Satisfied").

Division Differences

To analyze the differences between participants of the three NCAA competition levels (i.e., Division I, Division II, Division III), a one-way ANOVA was conducted to compare responses on all measures of coach-athlete relationship quality, as well as athlete satisfaction. ANOVA values for the overall CART-Q direct and meta-perspectives are shown in Table 5, along with the overall values for measures of athlete satisfaction. The magnitude of observed differences was calculated using the formula for Eta squared (η^2). Cohen (1988) classifies .02 as a small effect, .06 as a medium effect, and .14 as a large effect for this measure of effect size. All differences found by the ANOVA test constitute a small to medium effect.

To further delineate the observed differences, post-hoc comparisons were conducted using a Tukey HSD test. Participants who compete at the NCAA Division III level reported higher scores than those in Division I and Division II on all variables. No statistically significant differences were seen between Division I and Division II participants. The multi-

Table 3: *Results of t-tests and Descriptive Statistics: CART-Q and ASQ by Gender*

	Male			Female				
Measure	*M*	*SD*	*n*	*M*	*SD*	*n*	*t*	*df*
CART-Q								
Direct – Overall	5.75	1.19	156	5.66	1.20	231	0.795	385
Direct – Closeness	5.95	1.20	156	5.81	1.28	231	1.134	385
Direct – Commitment	5.45	1.32	156	5.36	1.40	231	0.659	385
Direct – Complementarity	5.78	1.25	156	5.73	1.12	231	0.443	385
Meta – Overall	5.60	1.17	156	5.48	1.22	231	0.926	385
Meta – Closeness	5.72	1.23	156	5.62	1.27	231	0.835	385
Meta – Commitment	5.42	1.24	156	5.29	1.34	231	0.931	385
Meta – Complementarity	5.61	1.22	156	5.50	1.27	231	0.886	385
ASQ								
Overall Satisfaction	5.12	0.90	156	5.07	0.92	231	0.561	385

Note. Equal variances were assumed.

Table 4: *Results of t-tests and Descriptive Statistics: CART-Q and ASQ by Sport Type*

	Team Sport			Individual Sport					
Measure	*M*	*SD*	*n*	*M*	*SD*	*n*	*t*	*df*	*d*
CART-Q									
Direct – Overall	5.52	1.27	217	5.92	1.05	170	-3.33***	385	0.34
Direct – Closeness	5.68	1.36	217	6.09	1.05	170	-3.24***	385	0.34
Direct – Commitment	5.22	1.44	217	5.63	1.25	170	-2.93**	385	0.30
Direct – Complementarity	5.58	1.24	217	5.97	1.08	170	-3.30***	385	0.34
Meta – Overall	5.35	1.27	217	5.75	1.07	170	-3.28***	385	0.34
Meta – Closeness	5.50	1.33	217	5.86	1.11	170	-2.81**	385	0.29
Meta – Commitment	5.20	1.35	217	5.52	1.21	170	-2.43*	385	0.25
Meta - Complementarity	5.32	1.32	217	5.82	1.10	170	-3.97***	385	0.41
ASQ									
Overall Satisfaction	4.96	0.98	217	5.26	0.77	170	-3.29***	385	0.34

Note. Equal variances were assumed. *p < .05, **p < .01, ***p < .001

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ple comparison results are presented in Table 6. A depiction of the results for overall scores on the CART-Q and ASQ is shown in Figure 1.

Correlational Analyses

A Pearson product-moment correlation coefficient was used to determine any associations between all scales of the CART-Q direct and meta perspectives and the overall score from the ASQ. There was a strong positive correlation between all measures of coach-athlete relationship quality and overall athlete satisfaction at the p < 0.01 level, with higher ratings of the coach-athlete relationship associated with higher ratings of athlete satisfaction. Table 7 has complete results.

Regression Analyses

To explore relationships between the independent and dependent variables, a standard multiple regression was used to

Figure 1: Differences between NCAA Divisions on overall CART-Q and ASQ scales.

(A) *Note.* D1 = NCAA Division I; D2 = NCAA Division II; D3 = NCAA Division III. **Division III statistically different from Divisions I & II, p < .05.

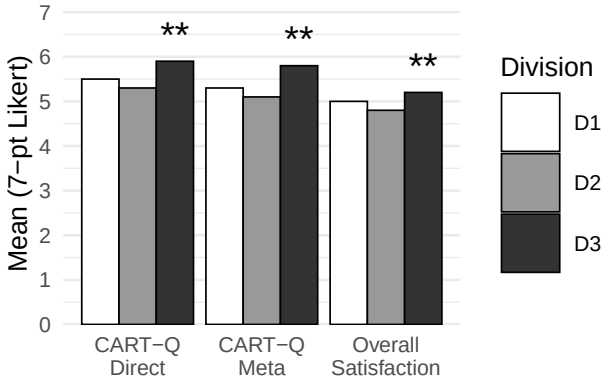

Table 5: *Results of ANOVA test statistics: CART-Q and ASQ by Division*

Scale		Sum of Squares	df	Mean Square	F	η^2
CART-Q						
Direct - Overall	Between Groups	18.16	2	9.08	6.55*	0.03
	Within Groups	532.53	384	1.39		
	Total	550.67	386			
Meta – Overall	Between Groups	17.33	2	8.67	6.16*	0.03
	Within Groups	540.70	384	1.41		
	Total	558.03	386			
ASQ						
Overall Satisfaction	Between Groups	9.43	2	4.72	5.87*	0.03
	Within Groups	308.75	384	0.80		
	Total	318.18	386			

Note. *$p < 0.01$

Table 6: *Descriptive Results of ANOVA Post-Hoc Comparisons: CART-Q and ASQ across Divisions*

	Division 1		Division 2		Division 3	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
CART-Q						
Direct – Overall	5.56	1.28	5.34	1.37	5.89**	1.03
Direct – Closeness	5.70	1.33	5.54	1.49	6.07**	1.07
Direct – Commitment	5.29	1.47	5.02	1.48	5.59*	1.24
Direct – Complementarity	5.63	1.28	5.39	1.31	5.94**	1.01
Meta – Overall	5.34	1.32	5.20	1.26	5.73**	1.07
Meta – Closeness	5.56	1.38	5.34	1.35	5.83*	1.11
Meta – Commitment	5.22	1.38	4.98	1.37	5.54*	1.18
Meta - Complementarity	5.35	1.39	5.22	1.26	5.77**	1.12
ASQ						
Overall Satisfaction	4.99	0.84	4.85	0.96	5.24**	0.91

Note. †Statistically different from D2 only, ††Statistically different from D1 and D2, *$p < .05$

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determine how measures of coach-athlete relationship quality predict ratings of athlete satisfaction (i.e., using the "3Cs" as multiple predictors). This approach was used to determine the unique variance in the dependent variable (i.e., athlete satisfaction) that each of the three independent variables explains. Two separate regressions were used; one for the CART-Q direct-perspective and one for the CART-Q meta-perspective.

The results of the first multiple regression analysis indicated that the three CART-Q direct-perspective predictors explained 51.3% of the variance in athlete satisfaction (R^2 = 0.513, $F(3, 383) = 136.70$, $p < .001$). Furthermore, ratings of Commitment significantly predicted athlete satisfaction (β = 0.43, $p < .001$), as did Complementarity ($\beta = 0.17$, $p < .05$). Both Commitment and Complementarity subscales made a statistically significant unique contribution to the variance explained by the model. See Table 8 for summary results.

Results of the second multiple regression analysis with the three CART-Q Meta perspective predictors explained 48.1% of the variance (R^2 = .481, $F(3, 383) = 120.21$, $p < .001$). Unlike the direct perspective, ratings on the subscale of Meta-Commitment did not predict athlete satisfaction ($\beta = 0.15$, p = .06), but both Meta-Closeness ($\beta = .23$, $p < .05$) and Meta-Complementarity ($\beta = .35$, $p < .001$) made statistically significant unique contributions to the variance in athlete satisfaction. Summary results are in Table 9.

Discussion

All measures of coach-athlete relationship quality had strong positive correlations with overall athlete satisfaction, with higher ratings of interdependence associated with higher ratings of athlete satisfaction. These results are substantiated in other populations (Jowett & Nezlek, 2012) and demonstrate a positive relationship between constructs from both direct and meta-perspectives. The strongest correlation was observed between athletes' overall self-perceptions of the coach-athlete relationship and satisfaction. In short, the coach-athlete relationship is linked with NCAA student-

Table 7: *Pearson Product-moment Correlations Between the CART-Q and ASQ*

Scale	1	2	3	4	5	6	7	8	9
CART-Q									
1. Direct – Overall	1	.971	.945	.942	.953	.801	.784	.843	.713
2. Direct – Closeness		1	.898	.869	.827	.778	.754	.819	.686
3. Direct – Commitment			1	.816	.861	.812	.826	.818	.704
4. Direct – Complementarity				1	.758	.706	.670	.774	.652
5. Meta – Overall					1	.964	.938	.947	.695
6. Meta – Closeness						1	.879	.863	.665
7. Meta – Commitment							1	.821	.640
8. Meta - Complementarity								1	.673
ASQ									
9. Overall Satisfaction									1

Note. All correlations are statistically significant at the $p < .01$ level.

Table 8: *Multiple Regression Results: CART-Q direct perspective subscales and ASQ*

Predictor	B	SE B	β
Direct – Closeness	0.12	0.07	0.16
Direct – Commitment	0.28	0.05	0.43**
Direct - Complementarity	0.13	0.06	0.17*

Note. $R^2 = .513$ (*$p < .05$, **$p < .001$)

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athlete satisfaction and this finding underlines the importance of considering the athletes' perspective in sport research (National Collegiate Athletic Association, n.d.; Poczwardowski et al., 2006; Wylleman, 2000).

Interestingly, males and females did not differ significantly in their ratings of coach-athlete relationship quality. Such a result contradicts other investigations that found females reported higher levels of interdependence than males (Jowett & Nezlek, 2012). Additionally, it has been noted that women tend to perceive greater similarity between their perceptions of commitment and those of their coaches than men (Jowett & Clark-Carter, 2006). There is evidence of gender influences in the coach-athlete relationship (Haan & Norman, 2020; Lopez de Subijana et al., 2021; Lorimer & Jowett, 2010; McShan & Moore, 2023), although the current results do not support this contention. More research is warranted to elucidate further gender dynamics in this relationship (Zhao & Jowett, 2023).

A less surprising finding was the difference in perceptions of coach-athlete relationship quality between team sport athletes and individual sport athletes. Participants who competed in individual sports, such as tennis and cross-country, reported feeling closer to and more committed to their coaches than athletes in team sports (e.g., basketball and football), which confirms previous findings reported in the literature (Lorimer & Jowett, 2009a; D. Rhind et al., 2012). The current study also noted differences in ratings of complementarity between sport types, with athletes in individual sports reporting more favorable perceptions than athletes in team sports. These results contradict the findings of (D. Rhind et al., 2012), who reported no differences across sport types on this dimension of the relationship. These inconsistencies may be due to the highly individualistic nature of the coach-athlete relationship across contexts. Moreover, Simons and Bird (2023) found no differences across sport types, which suggests that further investigation is warranted to understand these discrepancies across studies.

Participants from Division III institutions differed from their Division II counterparts on all measures of coach-athlete relationship quality and all but two measures from Division I respondents. These results suggest that there may be inherent differences in the Division III student-athlete experience. It is acknowledged that Division III sport competitors do not receive athletic scholarships and spend less time on athletics than their higher-level counterparts (National Collegiate Athletic Association, n.d.). However, this distinction might lead one to wrongly imply that their relationships with their coaches would be underdeveloped. The recruiting regulations at NCAA Division III institutions are less stringent than those in other divisions, which opens the way for a stronger coach-athlete relationship from the start, as coaches can communicate with prospective athletes more freely. Indeed, communication is a key component to healthy coach-athlete relationships (Davis et al., 2019).

Additionally, both coaches and student-athletes recognize that participation in Division III sports is more about personal

Table 9: *Multiple Regression Results: CART-Q meta perspective subscales and ASQ*

Predictor	B	SE B	β
Meta – Closeness	0.17	0.07	0.23*
Meta – Commitment	0.11	0.06	0.15
Meta – Complementarity	0.26	0.06	0.35**

Note. R^2 = .481 (*p < .05, **p < .001)

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enrichment than a springboard to professional athletics (National Collegiate Athletic Association, 2021). This focus on self-fulfilment and personal success may be the reason for stronger coach-athlete relationships at this level. However, it is essential to acknowledge that Division III competitors strive for performance excellence in competition, just as athletes at other levels do.

The present study also confirms the findings of (Lorimer & Jowett, 2009b), who found that athletes' meta-perspectives of the coach-athlete relationship were significantly and positively associated with ratings of satisfaction. Believing their coaches are trustworthy, committed, and friendly is a significant contributor to athletes' satisfaction. However, this finding also has implications for coaches. Coaches may have different perceptions of the relationship than athletes (Haugan et al., 2021), but the most important component is that the athletes' perception aligns with their preferences (Chelladurai, 1984; Rocchi & Pelletier, 2018). More specifically, the athletes' perceptions of coach empathy may be a mechanism that connects coach-athlete relationship quality with satisfaction (Jowett et al., 2012). Coaches can promote athlete satisfaction by developing and practicing empathy with their athletes. (Lorimer, 2013) provides recommendations for how coaches can enhance their empathic accuracy, including strategies such as avoiding biases and being reflexive. This area is ripe for future investigation.

As indicated in the multiple regression analysis, the single greatest contributor to athlete satisfaction was Commitment to their coach, followed by Complementarity as the other significant predictor. Since the Commitment subscale refers to the cognitive elements of the coach-athlete relationship, the way athletes think about the relationship is of paramount importance. Suppose they believe they are close to, committed to, and have a promising career with their coach. In that case, they are likely to report high satisfaction ratings. Such a finding highlights the significance of athletes' thought processes, as well as the necessity for coaches to comprehend and even target athletes' cognitive patterns. By seeking to encourage athlete commitment to the relationship, coaches may positively affect athlete satisfaction. However, there may also be negative implications in highly committed relationships (Nicholls et al., 2016) that should be considered in conjunction with the positive consequences.

Interestingly, with the Meta perspective subscales as predictors, Commitment does not make a significant contribution to athlete satisfaction. This suggests that athlete contentment is not affected by whether participants believe their coaches are committed to them. As such, satisfaction is influenced more by athletes' commitment to the relationship than by their perception of their coaches' commitment to the relationship. In other words, the direct-perspective of commitment is a better predictor of athlete satisfaction than the meta-perspective. The direct-perspective has also been shown longitudinally to predict the attainment of mastery achievement goals (Nicholls et al., 2017). This may be because athletes can more accurately assess their understanding of the relationship (i.e., direct-perspective) than they can assess how their coach might perceive it (i.e., meta-perspective). Even still, the meta-perspective has been linked with achievement goal orientation and intrinsic motivation in athletes (Adie & Jowett, 2010), which demonstrates the importance of assessing satisfaction from multiple perspectives.

Lastly, the component of the meta-perspective that was the single greatest contributor to ratings of athlete satisfaction was Complementarity (Closeness was also a significant predictor but to a lesser extent). Sport participants may experience higher levels of satisfaction when their coaches are at ease, respond to athletes' efforts, are ready to do their best, and adopt a friendly stance. Perceptions of coaching behavior are a crucial aspect of athlete satisfaction (Felton et al., 2021), and coaches would be wise to adopt behaviors that are perceived positively by their athletes (Kassim & Boardley, 2018).

Implications and Future Directions

The most noteworthy implication of this study is the clear association between the quality of the coach-athlete relationship and athlete satisfaction. Although this finding does not establish a cause-and-effect relationship, the quality of the coach-athlete relationship is an antecedent to athlete satisfaction. Sports coaches play a central role in the experience of student-athletes, and the relationship between these individuals is a key determinant of athlete satisfaction. Importantly, a universal approach (i.e., one-size-fits-all) to the relationship may not be effective. Indeed, there is a need for different leadership approaches within the same team (H. A. Riemer &

Chelladurai, 1995). By tailoring their coaching style to fit the unique needs of each athlete, coaches can enhance the relationship and positively impact athletes' ratings of satisfaction, which may lead to athletes staying in the sport for longer (Barnett et al., 1992; Wekesser et al., 2021). With student-athlete well-being as a central tenet of its mission, the NCAA could encourage coaches to engage in continuing education aimed at enhancing the coach-athlete relationship. These types of trainings can be effective (Smoll & Smith, 2006); future research should examine relationship maintenance strategies to identify the skills used by effective coaches. Some frameworks for enhancing the coach-athlete relationship already exist (Davis et al., 2019; D. J. Rhind & Jowett, 2010), but further research is needed to link these strategies with key sport outcomes (e.g., performance, satisfaction, etc.).

Limitations

Although the results of this study are intriguing, they are not without limitations. First, the sample consisted only of NCAA student-athletes, and the results are not generalizable to the broader population. Additional research is needed with participants from other levels of sport (i.e., youth, high school, and professional) to gain a better understanding of the contexts. Second, the data collection procedures relied on self-report measures. Although the CART-Q and ASQ are widely accepted as valid and reliable instruments, their results should be compared to more objective measures. Another important limitation is that coaches' perceptions of the coach-athlete relationship were not collected in this study. Future investigations should incorporate these perspectives to gain a more comprehensive understanding of the variables of interest.

Additionally, data collection took place early in the participants' spring semester. More longitudinal studies are needed to substantiate the major claims of the present study. Lastly, the primary statistical analyses were correlational, and results should be interpreted with caution. Although the findings of this study are intriguing, they do not imply a cause-and-effect relationship.

Conclusion

The results of this study represent a framework for future investigations that could inform the NCAA and coach education outlets. More importantly, though, are the implications for sport coaches who occupy a central role in student-athlete experiences. These practitioners are well-positioned to foster a positive coach-athlete relationship, which could ultimately lead to better outcomes for athletes. Therefore, it may be wise for sports coaches to engage in professional development aimed at fostering healthy relationship skills.

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A Preliminary Study to Explore Muscular Strength and Neuromuscular Control Differences in Elementary-aged Children

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This study explored differences in muscular strength (*MusS*) and neuromuscular control (*NC*) among elementary-age children in various demographics. Second-, third-, and fourth-grade children (n = 248; males n = 121; females n = 127) were selected from two Texas public schools. A nonrandomized cross-sectional approach was used to evaluate two unilateral strength tests (Dynamometer Grip and Single-Leg Three-Hop), two bilateral strength tests (Push-Up and Vertical Jump), and one neuromuscular control test (Side Step). The children improved as they advanced in grade on the unilateral grip test (p < .001), the unilateral hop test (p < .001), and the neuromuscular control test (p < .001). Males outperformed females on the unilateral grip test (p = .002), unilateral hop test (p < .001), and vertical jump test (p < .001). White children outperformed Hispanic children on the unilateral grip test (p = .007) and the push-up test (p < .001). The only *MusS* interaction showed that second-grade boys scored the highest on the push-up test (p < .001). An *NC* difference was found for grade (p < .001), showing that children's mean sidestep scores improved as the grades advanced. These findings suggest regular *MusS* and *NC* testing in children and a more comprehensive look at the demographic factors that influence the physical activity disparities in children's *MusS* and *NC* development.

Keywords: muscular strength, neuromuscular control, children, elementary school

Historically, deficits in muscular strength (MusS) and neuromuscular control (NC) appeared in adults as physical activity (PA) lifestyles declined. More recently, an alarming similar trend has appeared in elementary-aged children due to sedentary lifestyles and minimal daily physical activity (Centers for Disease Control and Prevention, 2022). Significant MusS deficits have been one of the most alarming results related to childhood physical inactivity (Wahl-Alexander & Camic, 2021). Childhood inactivity hinders proper musculoskeletal system growth as bones and muscles weaken through loss of limb use (Barnett et al., 2016; Smith et al., 2019). Lack of limb use can also create muscular weakness and imbalances between the dominant and non-dominant limbs, further disabling proper growth. Childhood inactivity is changing children's strength landscape (Stricker et al., 2020). This is worrisome as MusS may account for up to 70% of the variability in a child's range of motor skills, linking MusS tightly to motor competencies (Lloyd & Oliver, 2012). As MusS improves in children, so does NC. NC is the creation of new neurological pathways between the brain and the body through the movement of the body and limbs. Increases in NC allow children to exhibit more powerful and efficient movements and movement skills as they age (Musálek et al., 2018; Pedersen, 2019). Suppose a certain level of motor competence is not achieved in early childhood. In that case, a child's future motor skill development will be hampered, leading to less lifelong activity pursuits and an increased risk of all-cause mortality (Avigo et al., 2019; Hulteen et al., 2018). Consequently, proper MusS development is essential for proper NC development.

Although many factors influence inactivity, physical activity (PA) behavior disparities among children exist across various demographic populations, including age, sex, race, and socioeconomic status (SES) (Ball et al., 2015; Wilson & Bopp, 2023). Males tend to have higher PA levels and

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participate more in sport, leading to greater MusS development and increased performance over females in skills such as running, jumping, and throwing (Battaglia et al., 2021). PA participation also follows a "social gradient," where those who are more advantaged tend to be more physically active, less sedentary, and, therefore, less likely to suffer adverse health conditions (Ball et al., 2015; Wilson & Bopp, 2023). Research shows developmental gaps are often the result of poverty-related factors in the home environment, as children from more affluent homes show less developmental gaps in fine and gross motor skills, cognitive skills, language skills, and socio-emotional skills than children who are in lower-income cultures or households (Fink, 2021). Research shows a decline in MusS among youth over the past 10 years, highlighting the importance of assessing and monitoring MusS in children for appropriate interventions (Atkins et al., 2016; Laurson et al., 2017).

According to the National Institute of Health's Library of Medicine, MusS testing is an important component in revealing neurologic deficits, strength weaknesses, endurance weaknesses, and imbalanced limbs (Naqvi & Al, 2023). As MusS in elementary-aged children is exhibited by increased neuromuscular control (NC) (Stricker et al., 2020), the inclusion of a NC test is an appropriate addition to MusS testing. A gap remains in research for studies solely focused on MusS and NC of children's individual (unilateral) and combined (bilateral) limbs across varied demographics. Therefore, the purpose of this preliminary study was to explore MusS and NC differences among elementary-aged children by grade, sex, race, and SES. The study also aimed to establish preliminary baseline measurements for this elementary-age population.

Methods

Participants

The children in this study totaled 248 (n = 121 males; n = 127 females) from the second (n = 90), third (n = 77), and fourth (n = 81) grades of two different Texas schools. The assessments were scheduled in the physical education morning classes. An equal number of females and males (a minimum of 12) were selected from the general class population. Participation required parental consent for data collection. Participation inclusion criteria were (a) typically developing (children who can participate in physical education class without modifications), (b) no injury inhibiting participation in the physical education class, and (c) being present on the day of testing. White and Hispanic children constituted the primary racial groups included in the analysis due to the insufficient representation of other racial categories, limiting the generalizability of findings. The University Institutional Review Board (1801-65-1801) approved this study, followed by the consent of the superintendents, principals, physical educators, and parents. The participating children gave assent and were allowed to deny participation at any time.

Measures

The National Institute of Health's Library of Medicine deems MusS testing as an important component in addressing neurologic deficits, strength and endurance weaknesses, and imbalanced limbs (Naqvi & Al, 2023). These deficits can be seen either in unilateral or bilateral strength. As MusS in elementary-aged children is exhibited by increased NC (Stricker et al., 2020), the inclusion of a neuromuscular control test is an appropriate addition to the unilateral and bilateral strength tests. Certain MusS and NC measures used in a lab setting are not necessarily appropriate in a field setting. A persistent need exists for strength measurement tools that are valid, reliable, affordable, portable, and easy to use in physical education settings (Bogataj et al., 2020). The selected tests below met the administration requirements within the physical education setting and served as tools to measure unilateral and bilateral MusS and NC in children.

Dynamometer Single-Hand Grip Test

The Digital Dynamometer Single-Hand Grip Test (Baptista et al., 2022; Kunutsor et al., 2021) assesses unilateral upper-body MusS. Grip strength is associated with the prediction of musculoskeletal fitness, upper body strength, triglyceride levels, cardiometabolic health, cardiovascular disease, type II diabetes, and bone health during childhood and while traveling through adulthood (Baptista et al., 2022; Kunutsor et al., 2021). As a current and future indicator of health, grip strength is included in the MusS testing of children. Further, assessing right and left grip strength differences determines the asymmetry between right and left upper unilateral strength.

The Push-Up Test

The Push-Up Test (Plowman & Meredith, 2013), as introduced in the FITNESSGRAM, assesses bilateral upper body MusS and endurance in elementary-aged children (Hashim et al., 2018; Plowman & Meredith, 2013). The push-up uses upper-body mass recruitment, i.e., triceps, biceps, pectoralis major, and deltoids (Fawcett & DeBeliso, 2014). The push-up test has been found to have reasonable objectivity, reliability, and validity and is simple to administer (Hashim et al., 2018).

The Single-Leg Three-Hop Test

The Single-Leg Three (Booher et al., 1993; Hammami et al., 2022) assesses unilateral lower-body MusS and power in children (Hammami et al., 2022). This test is an easy, field-expedient, inexpensive test to administer and is often used

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for sport and physical activity readiness or return-to-play decisions after an injury (Guild et al., 2020; Millikan et al., 2019). For example, low scores in the single hop test are associated with increased injury risk in the thigh and knee (Guild et al., 2020). In contrast, limb asymmetry (limb distance differences) can help identify those who may be more prone to foot and ankle injuries (Brumitt et al., 2013).

The Double Leg Vertical Test

The Two-Foot Vertical Jump Test (Bogataj et al., 2020; Cho & Kim, 2017) assesses bilateral lower-body MusS. This test is a widely used measure of children's lower limb power and MusS (Bogataj et al., 2020; Watson et al., 2021). During active play and sports, children experience explosive contractions of the muscle-tendon attachment in their lower limbs (Stricker et al., 2020). If children do not develop proper lower limb MusS, these explosive movements may increase the risk of avulsion fracture until children are closer to skeletal maturity (Stricker et al., 2020). Therefore, assessing lower limb MusS can help identify children needing lower limb MusS interventions to prevent injury during physical activity.

The Side-Step-Test

The Sidestep Test (Cho & Kim, 2017) was developed to assess neuromuscular control (NC) of the lower body. It should be noted this test has not had any further validity or reliability studies conducted thus far. The sidestep test calls for entire core and lower body recruitment to complete the task, allowing for a better understanding of the brain-body connection. American Academy of Pediatrics has noted MusS gains in pre-adolescent children are displayed as neuromuscular advances rather than muscle hypertrophy, as seen in pubertal children (Stricker et al., 2020). Although one may not see the muscle physically developing, as with older children, a sign that it is developing correctly would be appropriate and efficient control of the limbs. As MusS and NC are so directly tied in elementary-aged children, a neuromuscular control step test was included in the study.

No rest intervals were required between repetitions of any test as the single-limb tests were administered by switching from right to left or left to right for each attempt, and no rest was taken between vertical jump attempts.

Procedures

The primary investigator (PI) scheduled an adherence training for three other researchers who would help collect the data. The other three researchers were affiliated with the same university as the PI, which included one PhD candidate and two staff members employed there. In October 2022, the PI and the three trained researchers, in line with previously established, research-based protocol for each test, administered all of the MusS and NC testing for both school districts. The PI assigned each researcher to one of the four indoor stations around the gym's perimeter. One test station consisted of two tests that took the least time (the Dynamometer Grip Test and the Vertical Jump Test). The single-leg three-hop test, the push-up test, and the sidestep represented the other three stations. Children wore the required physical education shoes and clothes on the testing day. Since the tests were all administered indoors, there was no issue with weather changes. The time of day was consistent because the school schedule remained the same throughout the year.

The children were informed about the purpose and technique of each test within one large group setting. They were then separated into eight groups and assigned one of the four stations. Once at each station, the researchers gave detailed instructions on performing their test and allowed the children to ask questions before beginning the tests. Once all children had completed their station test, each group rotated to the next station, as explained at the beginning of class, while the researchers remained at their assigned stations. Children could stop participation at any time. If a child stopped before all five tests were completed, their data was eliminated from the analyses.

Once the testing was complete, the PI gathered demographic data from the participating school principals, including free/reduced lunch qualification information from the district database (an indicator of SES and race). Free/reduced lunch was determined by the Texas Education Agency standards based upon the primary caretaker's income, regardless of benefits acceptance. Children's race was predominantly White or Hispanic (93.5% when combined). Other races included African American, Asian, Pacific Islander, and Native American Indian and were combined as one group due to their smaller representation percentage.

Data Security

School personnel provided demographic data, including free/reduced lunch program eligibility, to determine SES. Each child was assigned an ID number to preserve confidentiality. Data was collected, processed, and complied with general data regulation procedures.

Data Analysis

Data were cleaned and coded in Microsoft Excel, and analyses were performed using JASP software (version 17.3, JASP Team, 2023). Means (*M*) and standard deviations (*SD*) for each MusS and NC test were calculated by grade, sex, race, and free/reduced lunch eligibility. MusS (grip strength, single-leg three-hop, push-up, and vertical jump) and NC (side-step) differences across grade, sex, race, and free/reduced lunch status were assessed using a multivariate analysis of variance (MANOVA).

The Shapiro–Wilk test of normality was violated for the MANOVA, yet the analysis continued as the sample size was

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relatively large and the design was balanced. Levene's test showed homogeneity of variances for all dependent variables. Therefore, it can be assumed the variance is roughly equal across all groups being compared, which is a desirable outcome for follow-up ANOVAs. The test of multicollinearity showed a significant correlation between grip and push-up tests, and therefore, caution must be observed with that combination. Mahalanobis distance showed three multivariate outliers, which were removed accordingly. Box's test of equality of covariance matrices was statistically significant ($p < .001$), and the assumption of homogeneity of variance-covariance matrices was violated ($p = .002$). Therefore, Pillai's trace adjustment was performed for the MANOVA analysis.

Subsequent one-way ANOVAs were conducted to explore the MANOVA interactions and main effects, with a significance threshold set at $p < .05$. All ANOVA analyses are reported with Tukey's post hoc, which assessed the significance of differences between the pairs of group means.

Results

Descriptive statistics determined the means (*M*) and standard deviations (*SD*) of all MusS and NC tests by grade, sex, race, and free or reduced lunch qualifications. Table 1 provides upper-body MusS test means and standard deviations and Table 2 provides the lower-body MusS and NC test means and standard deviations. Caution should be used when interpreting the "Other" race results due to the low representation of this group. The small sample size and combining races (Black, Asian, and Native American) other than White and Hispanic into one category affects the reliability and generalizability of the findings. The "Other" category was removed from analyses and only reported as a descriptive statistic. Therefore, this study's results only generalize to White and Hispanic children.

Table 1 reflected hand grip strength increased as the grades advanced, while the push-up test scores decreased slightly as the grades advanced. Males and females showed higher right grip strength than left grip strength, while males scored higher on push-ups than females. The "Other" race group showed the highest average scores for all upper-body strength tests, followed by White, then Hispanic. Children who qualified for free/reduced lunch scored lower on all upper-body MusS tests than those who did not qualify for the lunch program.

Table 2 shows the three-hop and vertical jump scores increased as grades advanced. Males and females showed higher right-leg three-hop scores than left-leg three-hop scores. Males outperformed females on all lower-body MusS tests. Males also showed less difference between the right and left lower limb strength than females. The "Other" race averaged higher than White or Hispanic children for all lower-body MusS tests. Each race reflected higher right-leg three-hop test scores than left-leg three-hop test scores. Children who qualified for free or reduced lunch scored lower on all three-hop scores and the NC side-step.

NC (side-step) scores also increased as the grades advanced, while no differences were found between male and female mean scores.

Discussion

This study aimed to explore MusS and NC differences by sex, grade, race, and free/reduced lunch. A MANOVA was performed to determine MusS score differences by each independent variable and an ANOVA was performed for the NC scores across these same independent variables. Effect sizes ranged from moderate to high, except for the grip test by sex and race, which showed minimal effects with values of .03 and .02, respectively. All other effect sizes ranged from .04 to .26. Only one MusS interaction effect was found between sex and grade for the push-up test, $F(2, 242) = 2.88$, $p = .05$ (see Figure 1). Males showed steady progression in the push-up scores as they advanced in grade, however females did not show the same trend.

These outcomes support previous research showing a significant MVPA decline in girls (age six) and boys (age nine) (Farooq et al., 2020) and a rise in sedentary time (Janssen et al., 2016). This outcome may explain these baseline trends in upper body strength among females. If females decrease in PA three years sooner than boys, they may be recognized as needing MusS interventions earlier within childhood years. Additionally, main effect differences were found for MusS scores by grade, $F(2, 242) = 13.19$, $p < .001$, sex, $F(1, 242) = 6.76$, $p < .001$, and race, $F(1, 242) = 5.23$, $p < .001$. No SES differences were found on any of the MusS tests ($p > .05$). The follow-up analyses revealed children significantly

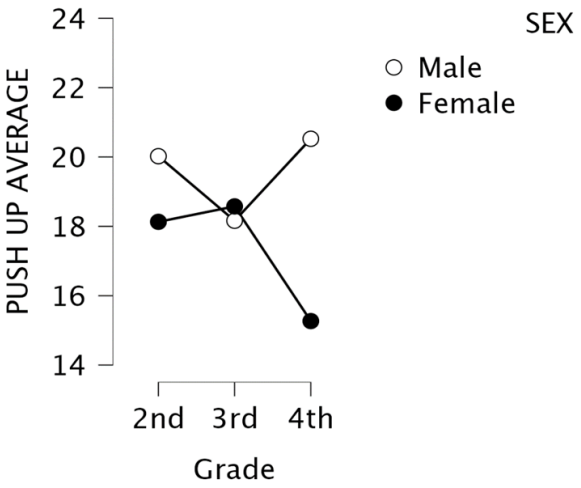

Figure 1: *Sex by Grade Push-Up test Interaction*

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Table 1: *Upper-Body Strength Means and Standard Deviations by Grade, Sex, Race, and Free/Reduced Lunch*

Variables	Right Grip (lb)	Left Grip (lb)	Average Grip (lb)	Grip Difference (lb)	Push-Up
Grade Average	28.7 (7.9)***	27.5 (7.3)***	28.4 (7.2)***	3.2 (3.0)	18.6 (9.3)
2 (n = 92)	24.5 (5.7)	24.0 (5.6)	24.2 (5.3)	2.8 (2.3)	19.2 (9.3)
3 (n = 81)	28.3 (7.6)	26.9 (7.0)	27.6 (7.0)	3.5 (2.9)	18.1 (8.7)
4 (n = 90)	34.0 (7.9)	32.9 (7.3)	33.4 (7.0)	3.7 (4.4)	18.3 (10.0)
Sex Average	28.7 (7.9)**	27.5 (7.3)**	28.1 (7.2)**	3.2 (3.0)*	18.0 (9.0)*
Male (n = 131)	30.0 (7.8)	28.7 (7.4)	29.4 (7.3)	3.1 (3.3)	19.8 (9.7)
Female (n = 132)	27.5 (7.8)	26.3 (7.0)	26.9 (7.0)	3.5 (3.4)	17.3 (8.8)
Race Average	28.7 (7.9)**	27.5 (7.3)**	28.1 (7.2)**	3.2 (3.0)	18.0 (9.0)***
White (n = 114)	29.7 (7.9)	28.4 (7.2)	29.0 (7.2)	3.4 (3.3)	20.4 (9.6)
Hispanic (n = 132)	27.8 (7.9)	26.7 (7.3)	27.3 (7.3)	3.2 (3.2)	16.7 (8.7)
Other (n = 17)	32.0 (10.3)	33.3 (10.2)	32.7 (9.9)	3.8 (4.2)	20.2 (9.2)
Free/Reduced Lunch Avg	28.7 (7.9)	27.5 (7.3)	28.1 (7.2)	3.2 (3.0)	18.0 (9.0)
No (n = 86)	29.6 (8.0)	28.8 (8.0)	29.2 (7.6)	3.8 (4.1)	20.8 (8.3)
Yes (n = 177)	28.6 (8.0)	27.5 (7.4)	28.0 (7.5)	3.1 (2.9)	17.4 (9.6)

Note. All values are presented as mean (standard deviation). ANOVAs were run to show effects of the independent variable on the dependent variable and are noted by: $^{*}p < .05$, $^{**}p < .005$, $^{***}p < .001$.

Table 2: *Lower-Body Strength and Neuromuscular Control Means and Standard Deviations by Grade, Sex, Race, and Free/Reduced Lunch*

Variables	Right 3-Hop (in)	Left 3-Hop (in)	Average 3-Hop (in)	Hop Difference (in)	Vertical Jump (in)	Sidestep
Grade Average	95.3 (27.3)***	91.0 (29.4)***	93.5 (26.4)***	14.4 (15.0)	8.7 (2.2)	25.1 (6.5)
2 (n = 92)	82.8 (25.1)	78.1 (23.4)	80.7 (21.3)	14.8 (16.7)	8.4 (1.7)	22.0 (5.7)
3 (n = 81)	94.5 (21.9)	87.3 (26.7)	91.5 (21.9)	15.3 (14.1)	8.7 (2.6)	25.3 (5.5)
4 (n = 90)	108.9 (27.6)	107.7 (29.7)	108.3 (27.7)	13.1 (14.1)	9.1 (2.4)	28.2 (6.8)
Sex Average	95.0 (27.0)**	90.0 (29.0)***	92.0 (26.0)***	14.0 (15.0)*	8.6 (2.0)***	25.0 (7.0)***
Male (n = 131)	100.3 (28.8)	96.4 (31.7)	99.0 (28.0)	16.2 (18.2)	9.2 (2.3)	25.0 (6.8)
Female (n = 132)	90.3 (24.8)	85.6 (26.0)	88.0 (24.0)	12.5 (10.6)	8.1 (2.0)	25.2 (6.3)
Race Average	95.0 (27.0)	90.0 (29.0)	92.0 (26.0)	14.0 (15.0)	8.6 (2.0)	25.0 (7.0)
White (n = 114)	96.7 (25.5)	91.3 (28.7)	94.0 (25.5)	14.5 (12.9)	8.4 (1.9)	25.0 (6.8)
Hispanic (n = 132)	92.6 (28.5)	89.8 (28.1)	91.6 (27.0)	12.6 (12.8)	8.8 (2.5)	25.3 (6.5)
Other (n = 17)	106.5 (25.2)	102.1 (35.5)	104.3 (27.1)	17.1 (10.2)	9.5 (2.2)	24.7 (5.1)
Free/Reduced Lunch Avg	95.0 (27.0)	90.0 (29.0)	92.0 (26.0)	14.0 (15.0)*	8.6 (2.0)	25.0 (7.0)
No (n = 86)	100.2 (26.2)	96.6 (28.5)	99.0 (25.0)	15.0 (16.8)	8.7 (2.0)	26.4 (6.7)
Yes (n = 177)	93.0 (27.4)	88.6 (28.9)	90.8 (26.8)	13.1 (10.2)	8.7 (2.3)	24.5 (6.4)

Note. All values are presented as mean (standard deviation). ANOVAs were run to show the effects of the independent variable on the dependent variable and are noted by: $^{*}p < .05$, $^{**}p < .005$, $^{***}p < .001$.

improved as they advanced in grade on the average unilateral grip test, $F(2, 242) = 42.66$, $p < .001$, and the average unilateral hop test, $F(2, 242) = 42.66$, $p < .001$. Males significantly outperformed females on the average unilateral grip test, $F(1, 242) = 9.71$, $p = .002$, average unilateral hop test, $F(1, 242) = 11.13$, $p < .001$, and the vertical jump test, $F(1, 242) = 18.74$, $p < .001$. White children significantly outperformed Hispanic children on the average unilateral grip test, $F(1, 242) = 7.36$, $p = .007$, and the push-up test, $F(1, 242) = 12.17$, $p < .001$.

The ANOVA revealed only one NC main effect difference for grade, $F(2, 242) = 23.34$, $p < .001$, showing children's side-step mean scores improved as grades advanced. A strong trend was found with free/reduced lunch, $F(1, 242) = 3.22$, $p = .07$, where those who qualified for the government aid program scored lower than those who did not qualify.

Grade level was not a factor in the vertical jump test outcome. From 1972–2015, studies showed children steadily decreased in measures of muscular power (Wahl-Alexander &

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Camic, 2021). During active play and sports, children experience explosive contractions of the muscle–tendon attachment in their lower limbs, similar to the vertical jump (Stricker et al., 2020). If children do not develop proper lower limb MusS due to inactivity, these explosive movements may increase the risk of avulsion fractures until children are closer to skeletal maturity (Stricker et al., 2020). This trend may highlight the need for increased childhood participation in more explosive movements, such as skipping, jumping, or running.

Sex played a significant role in MusS as males significantly outperformed females on every MusS test, which is supported in previous literature (Battaglia et al., 2021; Farooq et al., 2020; Janssen et al., 2016; Lloyd-Jones et al., 2022). Although a strength focus across males and females is equally important, the load placed upon the muscles during childhood may need to be modified according to sex.

Race was a significant factor in upper body strength tests, showing White children outperformed Hispanic children in the push-up and the average hand grip tests. PA participation for adults and children varies by race, and Hispanic races are less inclined to participate in muscle-strengthening PA (Battaglia et al., 2021). Disparities in youth PA due to SES and ethnic minority membership also pose a barrier to movement opportunities among the Hispanic population (Brumitt et al., 2013; Kuhn et al., 2021; Ning et al., 2021; Watson et al., 2021). Although increased upper-body MusS should be the goal of any childhood PA program, heightened priority for Hispanic children and female children should be considered.

For unilateral tests, the higher a group scored on a MusS test, the more evident the imbalance was between the dominant and non-dominant limbs. An underlying, silent issue with children who display greater strength may be that there is greater potential for an imbalance and, therefore, greater potential for injury as they mature (Atkins et al., 2016; Avigo et al., 2019; Kobayashi et al., 2014; Lloyd & Oliver, 2012; Musálek et al., 2018; Pedersen, 2019; Stricker et al., 2020). Children who present with higher MusS scores may need to focus on activities that include single-leg and single-arm activation to strengthen both dominant and non-dominant limbs. Stronger children may be in greater jeopardy of injuries due to MusS imbalance issues. Therefore, unilateral testing is pivotal when assessing the strength of less active and highly active elementary-aged children.

Increased MusS and NC are pivotal for decreased fracture incidents, increased motor skill development, and overall health (Avigo et al., 2019; Battaglia et al., 2021; Musálek et al., 2018; Stricker et al., 2020). With the PA decline among children, it is essential for those working with children to monitor MusS and NC development. This study aids in future MusS and NC assessments among children by giving insight into variables that may influence MusS and NC testing scores. Much research focuses on adult PA behaviors across age, sex, race, and socioeconomic status (Führer et al., 2021; Kuhn et al., 2021; Lloyd-Jones et al., 2022; Ning et al., 2021). This study is unique as it explores MusS and NC tests across various demographics during childhood. This is an essential first step to improve upon previous research, as gaps remain in childhood MusS trends accounting for grade, sex, race, or socioeconomic status. This study is additionally strengthened by reporting that MusS and NC testing measures used were portable, cost-efficient (roughly $120), and easily administered to children. As childhood inactivity rises, PA and MusS testing should be considered a public health priority to improve health and increase life-long mobility (Bogataj et al., 2020; Niessner et al., 2020). This MusS testing may aid future physical education literacy and curriculum standards for MusS testing and interventions among children.

Future studies should include the same MusS and NC tests with larger sample sizes and more race diversity to better generalize the findings across different regions and demographics. Future studies would also benefit from notating the dominant hand per child to compare the dominant grip across varied demographics instead of just the right and left grip. It would also be advantageous for a future study to consider the population's past or present extracurricular participation to better connect upper-body MusS deficits among different demographics with a larger population. In addition to future studies using these five assessments, it is recommended that these assessments be used in physical education classes to monitor weakness and growth among school-aged children. For implementation purposes, it would be necessary to create implementation videos and literature appropriate for PE teachers to administer these tests. These could be marketed as state or local PE professional development credit.

One limitation is the lack of race representation other than White and Hispanic due to availability in these schools. Another limitation is the lack of representation across different regions of America. However, this study provides an estimated guideline for educators and coaches who may want to strength test elementary-aged children. Finally, although the PI was present at every testing site and trained the three research assistants, there is always a chance of variations in data recording across the PI and the research assistants.

License

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Is there Proprioceptive Comfort?

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Sensory comfort, the idea that certain stimuli lead to positive feelings (e.g., calmness, relief, joy), has been well established for 'external' senses like vision and audition. However, despite 'internal' senses such as proprioception, the sense behind one's body position and movement, being well studied, their respective sensory comfort (and perhaps the lack of) has been virtually unexplored. Here, previous work related to the potential of proprioceptive comfort is reviewed to provide context as to whether proprioceptive comfort truly exists. From the basis of sensory comfort provided by body movement, pain relief, proprioceptive art, and their relationships with proprioception, the argument is made that proprioceptive comfort does exist. This opens the door for research expanding on its characteristics and having major implications for supplementing and revitalizing proprioceptive comfort in individuals with impaired proprioception.

Keywords: sensory comfort, sensory pleasantness, proprioception, proprioceptive comfort

Sensory comfort is the idea that certain sensory stimuli lead to positive feelings, including calmness, relief, or joy. Although there is no direct definition for sensory comfort, comfort has been defined (referencing tactile comfort) as a psycho-physio-physical state of neutrality with no pain or discomfort (Hatch, 1993; Kamalha et al., 2013; Slater, 1977). Various terminology is used when referring to this idea (pleasure, aesthetics, preference, sensitivity, etc.); however, throughout this paper, the term 'comfort' will be used predominantly.

Sensory comfort based on external stimuli (i.e., viewing, hearing, smelling, tasting, touching, etc., something around us) is relatively well studied (Gallace & Spence, 2011; Kringelbach, 2015; Markovic et al., 2007; Tiihonen et al., 2017). Most people can also easily pinpoint pleasurable aspects of those specific senses (e.g., calming music, soft blanket). However, sensory comfort becomes less clear when framing it around internal stimuli. For example, many people experience comfort from yoga or dancing without major external stimulation. Often, these activities involve an internal sense called proprioception, the internal awareness of one's body position and movement (Héroux et al., 2022; Marasco & Nooij, 2023; Moon et al., 2021). Proprioception is well established as a bodily sense within the literature; however, proprioceptive comfort (or potentially the lack thereof) is relatively unexplored. This paper aims to explore the question of proprioceptive comfort in humans and whether it truly exists in depth.

Comfort from Body Movement

From many anecdotal experiences, it's clear that body movement, whether running, swimming, yoga, or dancing, can be rather cathartic. Exercise has been shown to increase central monoamine levels of endorphins, norepinephrine, dopamine, and serotonin, improving individuals' moods (Alizadeh Pahlavani, 2024). The production of these 'happy' neurotransmitters could be the end of the story; however, could this also be a neurological response to proprioceptive comfort? Linking muscle movement with a happier (and more comfortable) mood can provide insight into a possible proprioceptive comfort mechanism. Endorphins and irisin may be the key. Endorphins can reduce pain specifically caused by muscle contraction. In contrast, irisin, released from muscles during exercise, has been shown to impact central monoamine levels and directly links muscles and the brain (Alizadeh Pahlavani, 2024).

Proprioception is an aesthetic sense based on the proprioceptive pleasure and comfort from viewing and participating in movement (Cole & Montero, 2006; Montero, 2006). The perfect example is dance because, at its core, dancing creates beauty in movement (Cole & Montero, 2006; Montero,

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2006). As Montero (2006) pointed out, if you ask a dancer why they move in specific ways, often the answer is because it is more graceful or aesthetically pleasing. Further, there is an important distinction in that when learning dance, vision is critical because the dancer relies on how their movement looks, whereas when dancing, proprioception is crucial because they must rely on how the movement feels. Through their proprioception, dancers can utilize visual imagery, but ultimately, proprioception is their main cue (Montero, 2006). Montero (2006) further pointed out that there are very skillful blind dancers, such as Alicia Alonso, who must rely primarily on proprioception while learning as well as performing their craft. This suggests that in the absence of vision, proprioceptive cues are sufficient to create an aesthetic and enjoyable experience for the dancer.

Outside of dancing, Montero (2006) posed that mirror neurons could serve as a potential mechanistic explanation behind perceiving proprioceptive comfort from simply watching others dance. Mirror neurons fire the same way when someone performs an action or watches someone else perform the same action (Rizzolatti et al., 1996). Spectators could be viewing the aesthetically beautiful movements, and their bodies would be sympathetic toward the graceful and calming motion as if it were their own. This extends beyond dance and can help explain why, for example, you can also gain a sense of relief when someone next to you cracks their back after a long day.

Similarly, yoga is an activity that many people find relaxing and can potentially provide proprioceptive comfort. A big component of yoga is controlled breathing, which increases proprioceptive awareness and provides a relatively immediate sense of calm. Further, controlled breathing can increase calming hormones like prolactin and oxytocin (Schmalzl & Sullivan, 2022). Over time, meditation practices like yoga have been shown to cause structural and functional changes in the somatosensory cortex and insula, both of which are part of the proprioceptive pathway (Schmalzl & Sullivan, 2022). Static stretching and conscious slower breathing have also increased parasympathetic activity and reduced stress (Sakurai et al., 2024). These findings suggest that utilizing muscles in calming manners through activities like yoga and stretching not only provides comfort but involves similar pathways as proprioception, hinting that they may provide specifically proprioceptive comfort. Although not immediately thought of as a proprioceptive activity, breathing does enhance proprioceptive awareness, which, at the very least, links the two with comfort and relaxation.

Assessing the impact of body movement on those without proprioception could help further elucidate if movement and exercise provide proprioceptive comfort. One example is from Ian Waterman, who lost his ability to move and his sense of proprioception and touch as a teenager. Although he relearned how to move utilizing visual input, he has shared that he does not have the same enjoyment from moving without proprioceptive and tactile sensations. Further, he seeks out deer to watch their graceful movements to enjoy proprioception visually (Cole & Montero, 2006; Tuthill & Azim, 2018). Other individuals with quadriplegia share similar sentiments in that there is no real substitute for the joy of being able to move and use your body physically (Cole & Montero, 2006). These anecdotes suggest that movement without proprioception is far less enjoyable, and mirror neurons may not be sufficient to produce comfort without an intact proprioceptive sense. This points to proprioception having a distinct role in providing comfort during movement and the possibility of a positive relationship between proprioceptive comfort and proprioceptive sensitivity. Perhaps those with impaired proprioception, such as older adults and individuals with a history of stroke (Henry & Baudry, 2019; Rand, 2018), have reduced proprioceptive comfort as a result.

Proprioceptive Role in Reducing Pain and Stress

In a literal sense, pain reduction provides a sense of objective comfort. Interestingly, proprioception is likely behind modern and innovative pain reduction methods. Techniques like transcutaneous electrical nerve stimulation, intramuscular stimulation, and spinal cord stimulation may sound like torture, but are methods of pain relief (Prochazka, 2021). The science behind the relief is primarily the Gate Theory of Pain, which states that intense sensory activation can inhibit the nociceptive (pain) signals from reaching the brain and thus create pain relief (Prochazka, 2021). Proprioception is involved because muscle spindles and Golgi tendon organs (GTOs), two primary proprioceptors (specialized sensory organs (Tuthill & Azim, 2018)), have the lowest thresholds to electrical stimulation. This means that spindles and GTOs are activated from stimulation quicker than other nerve fibers (most importantly, nociceptive fibers), suggesting that their proprioceptive input is behind the pain relief experienced from the above-mentioned stimulation techniques (Prochazka, 2021). A simple example of this in action was provided by Prochazka (2021) in that if you hit your thumb with a hammer, a common response would be to shake your hand back and forth. The 'stimulation' would be the hand shaking, which would send proprioceptive signals to the spinal cord (and the ascending pathway that follows (Ager et al., 2017)) before the nociceptive signals are sent, effectively inhibiting or reducing the pain response.

Proprioceptive feedback could also play a critical role in trauma therapy. A practice called Somatic Experiencing® utilizes attention to proprioception, interoception, and kinesthesia and has been shown to relieve patients' chronic and traumatic stress (Payne et al., 2015). The sympathetic (arousing) and parasympathetic (calming) nervous systems have a homeostatic relationship that requires balance. If this balance becomes impaired and, for example, shifts into a

sympathetic-dominant state, it can lead to harmful emotional and physiological stress (Payne et al., 2015). Sympathetic 'fight, flight, or freeze' activation results in faster breathing and heart rate to push greater amounts of oxygen and blood to areas that may need it, among other physiological changes. In contrast, parasympathetic 'rest and digest' activation results in a slower heart rate and muscle relaxation, among other changes, which help relieve stress and can provide comfort (Gellhorn, 1964; Payne et al., 2015).

Payne et al. (2015) pointed out that muscle activation can be limited in a sympathetic state as certain trauma responses are to completely freeze in place (e.g., tonic immobility) and dissociate. One may appear stressed from an outside perspective with indicators such as shaking, trembling, or postural changes. Payne et al. (2015) described these movements as releasing excess sympathetic activation. Movements like trembling, specifically involved with tonic immobility, may serve as the body's attempt to warm necessary muscles to prepare for a sympathetic defensive response (Payne et al., 2015). The thought is this could release the body from the frozen state and kick-start the cyclic balance that will facilitate parasympathetic activation (Payne et al., 2015).

In individuals who are in a sympathetic-dominant state, proprioceptive feedback from manual muscle activity can help communicate to the body that sympathetic arousal is unnecessary and trigger parasympathetic activation, resulting in stress reduction (Gellhorn, 1964; Payne et al., 2015). Similarly, in an experiment where rats were exposed to stressful environments via an inescapable shock, allowing them to fight each other reduced their adrenocorticotropic (stress) hormone levels compared to controls (Payne et al., 2015; Weinberg et al., 1980). These examples suggest that (in)voluntary muscle movement can serve as a proprioceptive outlet to reduce stress and ultimately create a more comfortable existence.

Proprioceptive Art

People typically perceive art as a visual or auditory experience; however, there has recently been interest in proprioceptive art. Although this may take a multisensory approach, proprioceptive art has been defined as art that would lose some meaning without proprioception (Spence, 2022). This makes it distinctly reliant on the proprioceptive sense. Carsten Höller, a Belgian-born German artist, is perhaps one of the best-known artists that purposefully incorporates proprioception into their work (Spence, 2022). Höller brought an 'Experience Exhibition' to New York in 2011, which included art that broke many individuals' perceptions of what art truly is. His exhibition included an entire room made to look upside down, a water tank where people could float weightlessly, and a mirrored carousel that people could ride that slowly spun in one direction, while the center column rotated in the opposite direction (Spence, 2022). His art is focused on distorting typical perception, forcing many viewers to rely on their own body's spatial awareness (i.e., proprioception). Proprioceptive art distorts the traditional view of art in a unique yet enjoyable way.

Interestingly, proprioceptive art has trickled into the research world as well. One of Höller's works, *The Pinocchio Effect* (1995), created a vibratory experience leading to an illusory perception of one's nose growing (Spence, 2022). This led to the Pinocchio illusion (and arm extension illusion) that researchers have used to examine proprioceptive manipulation (Burrack & Brugger, 2005; Michael & Park, 2016; Morris, 2020; Morris et al., 2024). Certain muscle vibrations can create proprioceptive illusions by utilizing proprioceptors and other mechanoreceptors (sensory neurons) such as Pacinian corpuscles (vibration sensors (Marasco & Nooij, 2023; Roudaut et al., 2012)). When perceived, these illusions spark a lot of joy in participants simply due to the unique experience of perceiving your nose growing when you're cognitively aware of the impossibility. Notably, these illusions specifically target proprioception and are perhaps one of the few possible examples of unisensory proprioceptive comfort. Typically, when eliciting proprioceptive illusions, participants are asked to wear a blindfold or close their eyes to eliminate the impact of visual cues (Burrack & Brugger, 2005; Michael & Park, 2016; Morris, 2020; Morris et al., 2024).

Conclusion

Sensory comfort is almost always multisensory, at least in a real-world setting. For example, a hike through nature could provide sensory comfort in many external forms (e.g., smelling fresh air, viewing beautiful landscapes, and hearing birds chirping) and internal (e.g., the hiking/movement itself). One reason internal sensory comfort may not be considered as readily is that it is much more challenging to separate it than one's external senses. If researchers seek to investigate visual comfort, they may place a participant in front of a computer screen and ask them to select their preferred visual stimuli. From there, researchers can dive into the specific features of preferred versus non-preferred stimuli. This formulaic structure isn't possible for proprioceptive comfort. Researchers cannot ask participants which 'version' of proprioception they prefer. However, they can ask about different proprioceptive activities, such as dancing, yoga, or therapeutic techniques. Learning from individuals with impaired proprioception, such as Ian Waterman, researchers can start to reveal the important role of proprioception in inducing proprioceptive comfort. This can be further expanded by examining the relationship between proprioceptive sensitivity and proprioceptive comfort in the general population.

It can be asserted that the potential for proprioceptive comfort derived from exercise is solely a chemical interaction distinct from sensory comfort. Other forms of potential propri-

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oceptive comfort are multisensory, and the perceived comfort could result from an external, rather than proprioceptive, sense. However, proprioceptive comfort may be far more complicated than external sensory comfort. To return to the definition of sensory comfort: "the idea that certain stimuli lead to positive feelings, including calmness, relief, or joy […] a psycho-physio-physical state of neutrality with no pain or discomfort." The defined comfort that body movements, therapies, and proprioceptive art can provide in a proprioceptive domain provides ample evidence for proprioceptive comfort. Further, several potential mechanisms exist behind proprioceptive comfort with various neurotransmitters and common pathways. Both the tactile and proprioceptive senses utilize the medial lemniscus-dorsal column and the same mechanoreceptors (Ager et al., 2017; Roudaut et al., 2012). Once tactile comfort mechanisms are further elucidated, they could be a strong stepping-stone toward revealing the mechanisms underlying proprioceptive comfort.

There is much more to explore in this domain, as is there with comfort from other external senses. Future research should explore comfort in models that account for individual differences in how people perceive proprioceptive comfort and allow for comparisons between intact, impaired, and removed proprioception. With those comparisons, the question of proprioceptive comfort can start to be definitively answered, and its benefits and applications can be effectively explored. This could provide valuable insights into using novel physiotherapeutic techniques and further understanding how to supplement and revitalize proprioceptive comfort to improve the quality of life in individuals with impaired proprioception.

License

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The Effect of Stroboscopic Vision on Dynamic Postural Stability in Uninjured Individuals

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Rapid adjustment and adaptation to multisensory cues are crucial for maintaining posture. The role of vision in static postural control was assessed by comparing eyes-open and eyes-closed performance; however, the impact of progressive visual occlusion during dynamic balance remains unclear. This study examined the effect of progressive visual occlusion with stroboscopic goggles on dynamic postural stability during jump landing. Sixteen uninjured, physically active adults participated in this study. Participants performed three single-leg landing trials at 50% of their maximum jump height, starting 70 cm away from the center of the force plate, while wearing stroboscopic vision goggles under three conditions: no-, low-, and high-occlusion. Ground reaction force data were analyzed using the dynamic postural stability index (DPSI). A one-way repeated-measure ANOVA and Hedges' g effect sizes were employed to assess differences among conditions in DPSI measures. Postural stability indices significantly increased (p = 0.026) with higher visual occlusion levels, indicating worse balance. However, the main effect of vision was only significant in the Medial-Lateral Stability Index (p = 0.009), specifically between no- and low-occlusion (p = 0.004, g= 0.81), resulting in a large effect size. With these results in mind, stroboscopic vision goggles, inducing progressive visual occlusion, impacted postural stability in uninjured individuals during jump landing. The findings suggest that the low-occlusion condition may introduce greater perturbations to postural stability during jump landing tasks compared to the no- and high-occlusion conditions. SV can offer unique challenges, particularly under low-occlusion conditions, and has the potential to serve as a valuable tool for training or sensory reweighting assessments in healthy individuals.

Keywords: strobe goggles, sensory reweighting, jump landing, dynamic balance

Maintaining postural stability requires integrating afferent information from proprioceptive, visual, and vestibular systems (Diener & Dichgans, 1988). This centrally mediated sensory integration must rapidly adjust to environmental and task constraints, employing "down-weighting" or "up-weighting" sensory cues to maintain postural equilibrium (Hwang et al., 2014). The capability to adapt and modulate the contribution of sensory input is defined as sensory reweighting (Nashner & Berthoz, 1978; Peterka, 2018).

Reweighting sensory information facilitates postural adaptations to interact with the surrounding environment successfully (Cenciarini & Peterka, 2006). For example, sudden changes in ambient light levels or deviating from a fixed surface, such as a transition to a moving walkway, necessitate rapid adjustments of sensory weights to react appropriately based on the most accurate information (Teasdale et al., 1991). In maintaining postural stability, the visual system assumes a dominant role (Paulus et al., 1984), providing information on object recognition and spatial orientation relative to the surroundings, thereby offering context for postural balance (Wade & Jones, 1997). When other systems are compromised, individuals often increase reliance on visual input. For example, those with vestibular or proprioceptive impairments tend to depend more on the visual system during postural tasks (Fukuoka et al., 1999). While heightened reliance on visual input may be beneficial temporarily, an increased dependency on the visual system can elevate the risk of injury during vigorous activities due to the excessive information the central nervous system may struggle to process (Peterka, 2018). Most studies assessed visual reliance by eliminating vision from the sensory equation. However, this approach is unsuitable for evaluating movements resembling real-world

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activities. Therefore, an alternative method is necessary to examine further the adaptive utilization of sensory information from reduced visual input during dynamic tasks.

Several studies have indicated that visual occlusion worsens balance (Abrahamova & Hlavacka, 2008; McKeon & Hertel, 2008); however, they typically employ a single level of visual occlusion. Common methods like eye-open (EO) and eyes-closed (EC) trials were used to investigate the role of visual input in reweighting during postural balance (Hazime et al., 2012; Springer et al., 2007). However, EO and EC trials hold two limitations: 1) they only allow static balance measures as individuals experience extreme conditions of visual occlusion due to limited methods for partial visual restriction (Kim et al., 2017), and 2) the EO/EC method results in inconsistent values during quiet stance, which questions the reliability of the technique to examine sensory reweighting abilities (Tjernstrom et al., 2015). Both issues inhibit the evaluation of a person's sensory reweighting through systematic visual perturbations during dynamic postural control assessments, which may better simulate real-world demands (D. Grooms et al., 2015). To better understand sensory reweighting dynamics, it is essential to determine whether high or low visual occlusion results in more significant tradeoffs in motor performance.

Stroboscopic vision (SV) goggles have recently enabled the systematic disruption of vision while performing dynamic tasks in the field (Kim et al., 2017). These goggles feature special lenses that alternate between transparency and opacity, producing intermittent visual occlusion conditions with a conveniently adjustable rate through a connected application on a phone or tablet. Previous studies by Kim et al. suggested that SV can be utilized to evaluate visual dependency, offering an alternative to the Sensory Organization Test(Kim et al., 2017, 2020). SV has also been suggested to interfere with visual information, prompting an adaptive strategy that forces sensory reweighting toward other sensory systems (D. Grooms et al., 2015).

Dynamic balance assessments, such as jump-landing, are necessary for challenging postural control and evaluating sensory reweighting during dynamic tasks (Kim et al., 2020; Wikstrom et al., 2006). Previous studies have highlighted single-leg jump landing as challenging for assessing dynamic postural stability(Brown et al., 2010; Ross et al., 2005). Adding SV goggles during jump-landing tasks can enhance our understanding of sensory reweighting. D. R. Grooms et al. (2018) investigated SV goggles during drop-landing, observing altered landing kinematics indicative of SV goggles influencing motor output through visual sensory contribution to neuromuscular control. However, drop-landing involved less force generation and adaptive neuromuscular motor strategies than forward jump-landing tasks (Kotsifaki et al., 2021). Further investigation using SV goggles during jump landing balance is necessary to identify visual contribution and subsequent sensory reweighting ability.

Therefore, the primary purpose of this study is to assess the effect of progressive visual occlusion on dynamic balance in uninjured individuals and identify its effect on postural stability during jump-landing. For this study, it was hypothesized that increasing visual occlusion during the jump-landing task would worsen all of the dynamic postural stability indices.

Methods

Participants

A total of 16 participants (Table 1), selected as a convenience sample from the university community, were included in the study. The study was supported by funds from the Graduate Research and Creative Activity of the University of Nebraska at Omaha. The authors declare no conflict of interest. Participants met the criteria of being free from lower extremity musculoskeletal injuries and were considered physically active, defined as those who participated in >90 minutes of physical activity per week. Exclusion criteria applied to individuals with 1) a history of surgical intervention or fracture in the lower extremity; 2) recent injury to the musculoskeletal structures of the lower extremity affecting the function of the joint and limiting their physical activity for at least one day within the previous three months; 3) history of neurological, neuromuscular, and/or chronic health conditions. Additionally, self-reported questionnaires, including the Foot and Ankle Ability Measure and the Cumberland Ankle Instability Tool, were utilized to assess the physical function of the ankle and foot (Hiller et al., 2006; Martin et al., 2005). All participants were required to have a score of >90% on both questionnaires to ensure the absence of functional ankle instability. The study protocol received approval from the Institutional Review Board at the University of Nebraska at Omaha (IRB# 201911-157).

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Table 1: *Participant Characteristics (n = 16)*

Characteristic	*M*	*SD*
Age (years)	23.5	4.6
Height (cm)	173.8	7.9
Mass (kg)	73.8	14.9
FAAM ADL (%)	100	0
FAAM Sports (%)	100	0
CAIT (score)	30	0
Gender (n): Male = 9, Female = 7		

Note. FAAM ADL = Foot and Ankle Ability Measure Activities of Daily Living; CAIT = Cumberland Ankle Instability Tool. Values are mean (*M*) and standard deviation (*SD*) unless otherwise indicated.

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Procedures

Participants provided signed informed consent on documents approved by the local Institutional Review Board. Subsequently, the participant's maximal jump height was measured from a standing position using a Vertec jump trainer (Sports Import, Columbus, OH). The measurement was taken to determine the 50% maximal jump height, ensuring consistency in each jump during the test session (Ross & Guskiewicz, 2004). Maximum jump height was assessed without the SV goggles. Also, participants were asked which leg they use to kick a ball to determine the dominant leg and were asked to only land with the dominant leg.

The level of occlusion can be adjusted to 8 levels, with a constant 100ms interval of transparency and a 67ms to 900ms interval of opacity. A previous study reported that visual occlusion lasting longer than 250 ms resulted in a complete loss of vision, impairing the ability to perform dynamic activities (D. R. Grooms et al., 2018). Therefore, three conditions were selected to provide sufficient visual perturbation while ensuring the task could be completed without significantly increasing the risk of injury: no-occlusion (NO), low-occlusion (LO: 100ms interval of opacity and transparency; level 2), and high-occlusion (HO: 233ms interval of opacity and then a 100ms interval of transparency; level 4). Then, participants underwent two practice jump-landing trials while wearing SV goggles (Senaptec Inc, Beaverton, OR) under three conditions. These practice trials aimed to identify any potential risk factors during the study. During these trials, participants were instructed to perform a double-legged jump and land on a single leg. Additionally, participants were instructed to focus on an arbitrary spot on the wall in front of them throughout the trial.

During data collection, the participant stood 70cm from the force platform in a double-limb-supported position (Ross & Guskiewicz, 2004). Visual conditions were applied at the start and turned off after each trial. The level of visual occlusion was applied in the order of LO, NO, and HO. The participant initiated the trial by jumping to their targeted height of 50% of the maximal vertical jump, reaching for the Vertec trainer target adjusted to that height, and landing on the force platform. After landing, the participants were asked to maintain balance as quickly as possible on their dominant leg for at least 10 seconds.

Nine recorded trials were obtained for each data collection, three per condition. Participants were asked to take a one-minute break after every three trials to reduce inconsistency due to fatigue. Successful trial was defined as 1) reaching the 50% max jump height by touching the tartget marker, 2) maintaining the base of the foot on the force plate without moving or sliding for 10 seconds immediately after landing, 3) no contact with the ground by the uninvolved limb, and 4) no supporting the wieght of the uninvolved limb on the involved limb after landing. A failed trials were noted for each condition and discarded and repeated after adequate rest.

Outcome Measure

The recorded ground reaction force (GRF) data were collected using the AccuPower force plate (AMTI Inc, Watertown, MA) at a sampling rate of 1000Hz. The analysis of GRF data followed the calculation method for postural stability indices described by Wikstrom et al. (2005). These postural stability indices measure the stability and dynamic balance during the landing task by computing the stability indices (SI) from anterior-posterior (AP), medial-lateral (ML), and vertical (V) directions along with a composite measure of dynamic postural stability index (DPSI). APSI and MLSI represent the fluctuations around a 0 point along the AP and ML axes of the force plate, respectively. VSI represents the fluctuation around the vertical axes of the force plate after normalization by the participant's body weight. All four stability indices were calculated for each trial and condition.

Statistical Analysis

Statistical analysis was conducted using the Statistical Package for Social Sciences software (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0 Armonk, NY: IBM Corp.). The independent variable was the level of visual occlusion (NO, LO, and HO). In contrast, the dependent variables comprised the postural stability indices (APSI, MLSI, VSI, and DPSI)—a one-way repeated-measures ANOVA was employed to assess the effect of visual occlusion on jump landing performance. The previous study (Kim et al., 2017) reported a large range of Cohen's d effect sizes from 1.05 to 2.61 between EO and SV conditions, which indicates a significant effect of SV during balance. Applying the average effect size of 0.6 to the calculation performed utilizing the G*power at an alpha of 0.05, and a beta of 0.95 showed that to meet the scientific objectives of this research,

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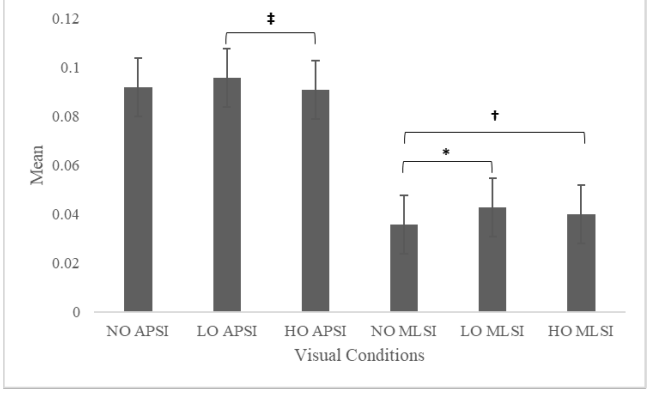
this study requires approximately 10 participants. The significance level was set at p ≤ 0.05, and Hedges' g effect size was interpreted as follows: 0.2 as a "small" effect size, 0.5 as a "medium" effect size, and 0.8 as a "large" effect size for the analysis.

Results

The results in Figures 1 and 2 represent the mean score of the postural stability indices for all participants during NO, LO, and HO conditions. As indicated in the figures, there were significant differences in postural stability indices as the level of visual occlusion progressed from NO to HO conditions. In a multivariate analysis, significant differences were observed in the within-subjects effect on the postural stability based on the levels of visual occlusion, $F(8,54)=2.428$, $p = 0.026$. The MLSI ($F(2,30)=5.474$, $p = 0.009$) was the only value to demonstrate a significant main effect on vision (Table 2). The LO condition demonstrated worse MLSI than the NO condition ($p = 0.004$) regarding postural stability indices (Table 3). Also, the largest effect size was observed for the NO-LO comparison in MLSI, with a value of 0.81 (0.09, 1.53) (Table 4).

Figure 1: *Mean values of APSI and MLSI under visual occlusion conditions (NO = no-occlusion, LO = low-occlusion, HO = high-occlusion) during single-leg jump landing.*

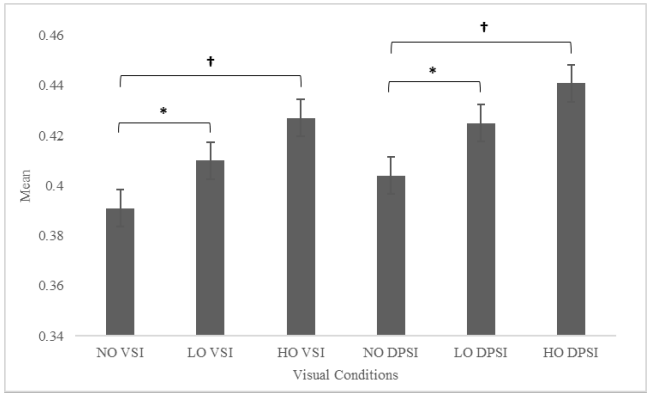


Note. Significant differences in APSI were observed between LO and HO, while significant differences in MLSI were found between NO and LO and between NO and HO. * indicates a significant pairwise difference from NO to LO; † indicates a significant pairwise difference from NO to HO; ‡ indicates a significant pairwise difference from LO to HO.

Discussion

Our study aimed to assess the effect of progressive visual occlusion on postural stability during a jump-landing task. Our findings indicate a significant effect of visual occlusion levels (NO, LO, and HO) on postural stability indices when vision was occluded during the jump-landing task. The hypothesis that the postural stability indices would demonstrate

Figure 2: *Mean values of VSI and DPSI on visual occlusion (NO, LO, HO) during jump landing.*



Note. Significant differences in VSI and DPSI were found between NO and LO and between NO and HO. * Indicates a significant pairwise difference from NO to LO; † Indicates a significant pairwise difference from NO to HO.

Table 2: *Repeated-Measures ANOVA Results for Postural Stability Indices*

Measure	*F*	*p*	Observed Power
APSI	1.368	0.269	0.241
MLSI	5.474	**0.009**	0.811
VSI	3.058	0.081	0.460
DPSI	3.106	0.078	0.465

Note. APSI = Anterior-Posterior Stability Index; MLSI = Medial-Lateral Stability Index; VSI = Vertical Stability Index; DPSI = Dynamic Postural Stability Index. Bolded p value indicates statistical significance at $p \leq 0.05$.

increased values with progressive visual occlusion during the jump landing task was only partially supported. Our main finding demonstrated significantly worse MLSI values during jump landing, specifically between the NO and LO conditions ($p = 0.004$). The effect of systematic visual occlusion achieved by the SV and the subsequent decline in balance quality aligns with findings from previous studies (Kim et al., 2017; VanDeMark et al., 2021). The compromised balance post-landing can be attributed not only to the significant role of the visual system on postural stability (Redfern et al., 2001) but also to the decreased ability to perceive vertical cues during the landing phase. Previous research suggests that visual cues aligned with gravity enhance postural control (Balestrucci et al., 2017; Goodworth & Peterka, 2012; Peterka, 2002). Goodworth and Peterka (2012) reported increased reliance on visual cues for feedback aligned with the earth's vertical to maintain lower extremity balance. Thus, it is possible that the conditions created by the SV reduced the visual system's capacity to detect vertical cues and maintain balance.

Table 3: *Descriptive Statistics for Postural Stability Indices by Visual Condition*

Measure	NO	LO	HO
APSI	0.092±0.016	0.096±0.021	0.091±0.024‡
MLSI*	0.036±0.007	0.043±0.010†	0.040±0.012
VSI	0.391±0.130	0.410±0.128†	0.427±0.173‡
DPSI	0.404±0.128	0.425±0.126†	0.441±0.170‡

Note. NO = no-occlusion; LO = low-occlusion; HO = high-occlusion. APSI = Anterior-Posterior Stability Index; MLSI = Medial-Lateral Stability Index; VSI = Vertical Stability Index; DPSI = Dynamic Postural Stability Index. Values are mean ± standard deviation. * indicates a significant univariate effect of vision ($p \leq 0.05$). † indicates a significant effect on vision compared with the NO condition ($p \leq 0.05$). ‡ indicates a significant effect on vision compared to LO condition ($p \leq 0.05$).

The findings are interesting, as MLSI was the only direction demonstrating a significant difference. Previous research has indicated that single-leg jump landing can increase hip adduction, hip internal rotation, and knee internal rotation, contributing to greater frontal plane instability (Taylor et al., 2016). The mechanical characteristics of the ankle and potential slight lateral deviation in the jump path might have specifically influenced the MLSI value (Wikstrom et al., 2008). Additionally, in this forward jump-landing task, where horizontal distance and jump height were consistent for each visual condition, the similarity in the AP jump direction and subsequent post-landing recovery of balance may stem from preplanned motor strategies in the AP direction, aimed at minimizing propulsion force and maintain balance. Conversely, stability in the ML direction may have needed to be addressed due to the perceived lesser threat to task completion and potentially greater variability in each jump landing trial. The increased difficulty in maintaining balance might have elicited the hip strategy for postural equilibrium, generating horizontal force against the surface and causing a greater ML motion (Horak & Nashner, 1986). However, further investigation, including kinematic variables, is warranted to better comprehend the altered motor patterns during dynamic landing under SV conditions.

The large effect size observed from the transition between NO to LO conditions may be attributed to asymmetric sensory reweighting during sudden sensory perturbation (Jeka et al., 2008). The authors reported a more rapid reweighting of sensory cues by participants to maintain postural stability from low-to-high visual perturbation compared to the high-to-low condition. The authors interpreted this as participants recognizing the sudden alteration in sensory information as a greater threat to instability, resulting in an asymmetrical dynamic reweighting of sensory cues to maintain stability. For example, encountering an unexpected loss of visual input, such as changes in ambient brightness when entering a tunnel, prompts the brain to perceive this sudden change as a heightened threat to stability and swiftly reweight sensory inputs to maintain postural stability, in contrast to emerging from the tunnel and regaining visual acuity. This mechanism might explain the substantial differences observed in our study between NO and LO conditions, which are attributable to increased visual perturbation. However, asymmetric sensory reweighting does not explain our result of decreased values in the HO condition compared to the LO condition. In summary, the significant difference between NO and LO conditions may stem from our natural reaction of recognizing greater threats in LO conditions compared to NO conditions, leading to rapid asymmetric sensory reweighting.

We considered two plausible explanations for the occurrences during the HO condition: 1) forced sensory reweighting might have resulted in less disruption in postural stability, enabling adaptation to environmental constraints, and 2) a potentially induced practice effect due to the testing protocol might have contributed to the improvement in balance.

Forced Sensory Reweighting

The forced sensory reweighting could explain the stability during the HO condition due to the excessive perturbation applied to the visual system. In prior studies, an increase in perturbation amplitude to sensory input was perceived as less reliable information about self-motion (Logan et al., 2014; Peterka, 2002). Consequently, the postural control system tends to down-weight its influence to maintain stability (Logan et al., 2014; Peterka, 2002). This concept can explain our findings of increased stability in the HO condition compared to the LO condition. SV is suggested to force adaptive sensory reweighting strategies by engaging proprioceptive or vestibular functions to compensate for decreased visual feedback (D. Grooms et al., 2015; Kim et al., 2017). The substantially increased perturbation amplitude during the HO condition may have forced the reweighting of sensory input toward proprioceptive and vestibular functions, allowing adaptation to overcome environmental constraints.

However, the LO condition might have needed to provide a sufficient perturbation level, leading participants to continuously focus on visual input rather than adjusting the weight of sensory information to other modalities, resulting in a worse balance. Thus, the LO condition could introduce additional challenges to the visual system during a dynamic balance training regimen. If the HO condition with SV can induce forced sensory reweighting, extended training with SV might reduce the reliance on visual information and enhance the utilization of lost proprioceptive function during dynamic postural control. However, further investigation is warranted to explore the dynamics of forced sensory reweighting and the impact of prolonged training with SV on improved balance.

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Table 4: *Hedges' g Effect Size Calculations for Pairwise Comparisons*

Condition	Correlation	Hedges' g	CI for Effect Size	
			Lower Bound	Upper Bound
NO-LO APSI	0.89	0.32	-0.4	1.02
NO-HO APSI	0.84	-0.11	-0.8	0.59
LO-HO APSI	0.94	-0.51	-1.2	0.2
NO-LO MLSI	0.62	0.81	0.09	1.53
NO-HO MLSI	0.66	0.50	-0.2	1.2
LO-HO MLSI	0.71	-0.28	-1	0.42
NO-LO VSI	0.97	0.52	-0.2	1.22
NO-HO VSI	0.94	0.63	-0.1	1.34
LO-HO VSI	0.93	0.28	-0.4	0.98
NO-LO DPSI	0.97	0.55	-0.2	1.26
NO-HO DPSI	0.94	0.64	-0.1	1.35
LO-HO DPSI	0.93	0.27	-0.4	0.96

Note. NO = no-occlusion; LO = low-occlusion; HO = high-occlusion. APSI = Anterior-Posterior Stability Index; MLSI = Medial-Lateral Stability Index; VSI = Vertical Stability Index; DPSI = Dynamic Postural Stability Index. CI = Confidence Interval.

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Testing Protocol

Our testing protocol may have induced a practice effect, improving balance during the HO condition trials. Visual occlusion levels were ordered during data collection as LO, NO, and HO. We recorded error trials for each condition per participant (total count: LO:44; NO:12; HO:28; mean: 2.75, 0.75, and 1.75, respectively), observing a higher number of error trials during the LO condition, which were excluded. Participants, anecdotally, mentioned that NO condition trials were notably easier after LO condition trials. This suggests that participants adjusted to intermittent visual disruption during LO condition trials, potentially resulting in improved balance during subsequent NO and HO trials. Multiple familiarization trials and prior experience with the LO condition experiences contributed to a practice effect, enhancing performance during the HO condition. Alternatively, this could indicate forced sensory reweighting from visual input to proprioceptive and/or vestibular functions to maintain postural stability (Logan et al., 2014).

Based on our results, the SV can introduce novel challenges to the sensorimotor system, especially under LO conditions. SV may serve as a training or sensory reweighting assessment tool in healthy individuals (Kim et al., 2020). The utilization of SV might overcome the current limitations of EO/EC methods by enabling dynamic movements while still providing challenges similar to the EC conditions (Kim et al., 2017, 2020), offering a closer representation of the real-world environment. However, future studies should investigate whether SV promotes sensory reweighting ability and reduce visual dependency. Additionally, exploring the effects of SV on individuals with musculoskeletal injuries during dynamic tasks, such as those with anterior cruciate ligament injuries or chronic ankle instability, requires further examination.

We must acknowledge several limitations, including 1) the absence of a comparison group, 2) the lack of kinematic and extensive kinetic data, and 3) the non-randomization order of visual occlusion applied to the participants. Future investigations aiming to compare the effect of SV on sensory reweighting should consider recruiting patient groups, such as chronic ankle instability or anterior crucial ligament reconstruction, to detect group differences and assess the potential application of SV in rehabilitation. Additionally, for a more comprehensive understanding of balance strategies and muscular output during balance maintenance, kinematic and/or further kinetic data are recommended for future studies. Lastly, the testing order was arbitrarily chosen based on consistent results in previous studies (Kim et al., 2017; VanDeMark et al., 2021), regardless of randomization. To mitigate the potential practice effect, randomizing the order of visual occlusion applied to participants would benefit future investigations.

Conclusions

This study found significant differences in postural sway during the jump-landing task under progressive visual occlusion by SV goggles. Specifically, significant differences were observed in MLSI values during the transition from NO to LO condition. The LO condition may provide greater perturbation during dynamic postural control in uninjured individuals. Therefore, further studies should examine the effect of utilizing the LO condition during jump landing tasks as a training or rehabilitation method to identify its potential effectiveness.

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Teamwork Makes the Dream Work: Strategies for Successful Interdisciplinary Collaboration and Research (IDCR) in Kinesiology

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The field of Kinesiology has evolved in many ways, from preparing effective physical educators and coaches to preparing pre-rehabilitation sciences students (e.g., physical and occupational therapy, chiropractic, and physician assistant studies). Throughout our evolution, we have led the charge in developing interdisciplinary departments that engage professors in a wide variety of academic disciplines. Given our need to continue to evolve, and embrace the promise that interdisciplinary collaboration and research (IDCR) hold to help bring our discipline together, the purpose of this paper is to: (a) define and clarify terms; (b) discuss reasons why Kinesiology should engage in and lead IDCR; (c) present some challenges with IDCR; (d) make some suggestions for successful IDCR; (e) propose 4 dimensions for IDCR in Kinesiology and provide some examples of each (e.g., Health & Medicine, Technology & Data Science, Education & Community Engagement, and Business & Industry); and (f) and suggest some future directions for IDCR.

Keywords: team science, interprofessional, cross-disciplinary, translational research, knowledge integration

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What are some of the biggest challenges facing Kinesiology today? When I asked ChatGPT to respond to that question, some interesting topics came to the forefront (OpenAI, personal communication, October 12, 2025). Note that the topics were generated by AI; the text that follows each topic is my own:

Defining the scope and finding our identity. We DO have an identity crisis in Kinesiology, and it makes it difficult to brand ourselves, facilitate understanding of what we do, collaborate amongst ourselves, and importantly, it makes it difficult for students to find us because we have so many different names (e.g., exercise science, physical education, sport science, kinesiology, etc.) (Newell, 1990). Unfortunately, the fragmentation in our disciplinary names can mirror fragmentation within our disciplines and departments. Should we take a page from Biology, Chemistry, or Psychology and commit to a common name?

Program sustainability. Amid the challenges facing higher education today, we need to find ways to remain viable. One thing that should bolster our viability is that virtually everyone benefits from learning to move their body efficiently and effectively. For example, it is hard (and potentially dangerous) for people to learn how to perform a clean and jerk powerlifting move without progressions and coaching.

Funding and resource constraints. We live in a world where every university is seeking ways to grow resources and justify spending amid budget cuts. Working together and bringing multiple disciplines to the table should lead to better decision-making and more sustainable, viable programs.

Professional pathway ambiguity. Students sometimes struggle to find secure job opportunities, and many programs that Kinesiology students pursue are overcrowded (e.g., personal training, group exercise instruction, strength & conditioning). Therefore, it is important to train students for a variety of career opportunities, so they can make decisions about their future from an interdisciplinary perspective.

Adapting to technological and data-driven change. Our field is changing quickly, with AI, new wearables, motion capture, and data analytics software now available. We need to produce students who think critically and have malleable skill sets – so they can adapt to these changes. We also need to learn to use AI productively to facilitate high-level teaching and learning.

Teacher education and physical literacy decline. There are

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fewer students pursuing physical education teaching careers at a time when this generation may be the first that might not outlive their parents due to high obesity, hypokinetic disease, and inactivity rates. Finding ways to offer career-savvy training in multiple areas of teaching is key to the success of teacher education. At our university, the pedagogy faculty also advises students to make sure they stay on track for success and ultimately, graduation.

Ethics in human performance and data analytics research. Given the financial potential and the desire to produce the best athletes possible, ethical issues have arisen in the collection of data for human performance research (e.g., Who controls the data?; Are the data private?; and Do algorithms show bias?).

Interdisciplinary and interprofessional collaboration. Yes, ChatGPT came up with this one, and the challenges to be addressed in this article include departmental silos and discipline-specific vocabularies and methodologies. There is clearly a need to continue to develop interdisciplinary collaboration within Kinesiology.

Now that we have a list of the most challenging problems facing Kinesiology today, what if we could bring together the best minds to solve them? THIS is exactly the premise of this paper; we need to enhance our collaborative and interdisciplinary work. We need to work smarter together versus harder independently. Given the need to enhance interdisciplinary collaboration and research (IDCR), and to address the most challenging issues facing Kinesiology and beyond, the purpose of this paper is to: (a) define and clarify terms; (b) discuss reasons why Kinesiology should engage in and lead IDCR; (c) present some challenges with IDCR; (d) make suggestions for successfully implementing IDCR; (e) propose 4 dimensions for IDCR in Kinesiology and provide some examples of each (e.g., Health & Medicine, Technology & Data Science, Education & Community Engagement, and Business & Industry); and (f) suggest future directions in IDCR.

Defining Terms

To best understand the purpose of this paper, it is important to draw on colleagues' work to define interdisciplinary collaboration, research, and related terms. These terms are often used interchangeably, and I advocate that careful consideration should be given to all terms so that the most appropriate term(s) can be used in each situation.

Table 1 summarizes terms related to interdisciplinary collaboration and research.

Clearly, there is overlap between terms, and there are times when any of the terms in Table 1 can be used. For example, some challenges lend themselves to disciplinary focus, whereas others can benefit from multidisciplinary, transdisciplinary, and interdisciplinary collaboration and research. Interprofessional education and practice are formalized and applied to improve the quality of healthcare practice within health-related disciplines, and there is research to support the use of IPE and IPP; specifically, students and medical professionals can benefit from understanding other professional roles (i.e., scope of practice), practicing teamwork, and learning about conflict resolution; patients can benefit from reduced errors, and they report enhanced satisfaction (Zenani et al., 2023).

Importantly, the U.S. National Academy of Sciences (2005) defines interdisciplinary research as: "A mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from 2+ disciplines to advance fundamental understanding or to solve problems where solutions are beyond the scope of a single area of research practice." According to Newman (2023), interdisciplinarity can be further broken down into collaborator interdisciplinarity and project interdisciplinarity. Because Kinesiology is an interdisciplinary field by its nature, it is vital that we work together, avoid fragmenting or de-valuing disciplines, and seek ways to enhance IDCR.

Why Should Kinesiology Participate in Interdisciplinary Collaboration and Research? What Are the Benefits?

Arguably, the most important reason Kinesiology professionals should engage in IDCR is that we are already interdisciplinary, and with enhanced interdisciplinary collaboration and research, we can provide more comprehensive and effective solutions to complex problems (Brown et al., 2023). Our world is becoming increasingly complex, and solving problems is becoming a more desirable job skill. Research suggests that solving problems from an interdisciplinary perspective yields more creative and successful solutions, and it facilitates "buy-in" from a larger number of individuals (Stvilia et al., 2010).

Another reason why engaging in IDCR is important is that it advances our field. Ideally, it provides individuals from disciplines outside kinesiology with a new lens through which to respect Kinesiology, given our breadth and expertise in human movement. IDCR can also lead to shifts in disciplinary perspectives, resulting in the creation of something new (Vladova et al., 2025; Yang & Heo, 2014). Finally, individuals who participate in IDCR report feeling very satisfied with their work, including "relational dynamics which promote dissemination of knowledge across a broad range of research fields" (Yang & Heo, 2014, p. 734).

What are Some Challenges with IDCR?

In addition to the reported benefits of IDCR mentioned in the previous section, challenges exist. One of the main challenges is that IDRC operates in contrast to a siloed academic discipline paradigm, in which academic success is typically defined as independent scholarship rather than collaboration (Vladova et al., 2025). A second challenge is the use

Table 1: *A summary of terms related to interdisciplinary collaboration and research*

Term	Definition	1 word summary *from Vladova et al. (2025)
Disciplinary	Knowledge flows within discipline and does not integrate much with other disciplines Vladova et al., 2025	siloed*
Multidisciplinary	Knowledge that combines disciplines and methods Burns & Collins, 2023; Vladova et al., 2025	additive*
Transdisciplinary	Knowledge that goes beyond, through and across Burns & Collins, 2023; Vladova et al., 2025	holistic*
Interprofessional Education (IPE)	Education specific to healthcare disciplines where 2+ professions learn about, from, and with each other to enable effective collaboration and improve health outcomes WHO, 2010	education
Interprofessional Practice (IPP)	Healthcare practice where multiple workers from different professional backgrounds work together with patients, families, carers, and communities to deliver the highest quality of care WHO, 2010	practice (Think Mayo Clinic)
Interdisciplinary	Knowledge that makes connections between, among, and reciprocal Burns & Collins, 2023; Vladova et al., 2025	interactive*

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of different terminology, writing styles, evaluation, and statistical analyses across disciplines (Newman, 2023; Vladova et al., 2025). Table 2 presents examples of differences in disciplinary language between Kinesiology and Public Health. These disciplinary differences can lead to communication difficulties and conflict unless participants in IDCR work hard to learn about other disciplines and to communicate regularly and effectively.

A third challenge of IDCR is that it is hard to find information about interdisciplinary research and conducting IDCR projects because it is conducted within a variety of academic disciplines, published in different journals, and there is not much existing research on strategies to conduct IDCR (Newman, 2023; Vladova et al., 2025). In addition, within Kinesiology, disciplinary power struggles and hierarchies can occur, and if faculty are in different buildings, geographic challenges may arise.

Strategies for Success with IDCR

Although there are challenges with IDCR, several approaches can be used to ensure successful outcomes. Below are some recommended strategies combined from papers by Brown et al. (2023) and Burns and Collins (2023). These strategies can and should be utilized as a proposed framework of action for Kinesiology.

Most importantly, it is essential to identify and define the problem using terminology that makes sense to all participating disciplines. Once the problem is identified, it is easier to determine a future course of action. Secondly, the expertise needed to solve the problem should be identified. One recommendation is to do an "aptitude test" for prospective team members. In other words, in addition to choosing team members for expertise, examine their skills in team collaboration, passion for interdisciplinary work, and willingness to learn about other disciplines (i.e., "intellectual humility") (Vladova et al., 2025). Once team members are identified, it is vitally important to develop a collaborative culture. That includes busting down silos and hierarchies, building shared goals and language (i.e., working together on issues), having respect and appreciation for all team members, facilitating regular communication, compromising when necessary, and completing assignments in a timely fashion. Next, it is important to develop a vision or framework for problem-solving. This should be done with all team members involved in discussions and should include examining the logistics and processes required. For example, when multiple individuals are sharing data and working on a project, authorship order, roles/responsibilities, and data control should be identified and ideally, included in an MOU. Lastly, it is important to identify the key performance indicators (KPIs), which are outcome metrics that determine a project's level of success.

Table 2: *Examples of differences in disciplinary language between Kinesiology and Public Health*

Concept	Kinesiology Terms	Public Health Terms
Population/Unit of Focus	Athlete, Patient, Participant	Population, Community, Vulnerable Group
Health Outcomes	VO_2max, Lactate Threshold, Muscle Strength, Flexibility	Morbidity, Mortality, Quality-Adjusted Life Years
Measurement/Data	Gait Analysis, EMG, EEG, Metabolic Cart, DEXA	Surveillance, Prevalence, Incidence, BRFSS
Statistical Analyses	ANOVA/ANCOVA, Correlation Matrix, Regression Analysis	Odds Ratio, Relative Risk, Hazard Ratio, Sensitivity, Specificity, Cox Proportional Hazard, Hierarchical Models

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Four Dimensions of IDCR in Kinesiology

Although there could be many examples of IDCR projects featured in this section, Table 3 lists four (4) specific dimensions in which IDCR occurs—with examples: Health & Medicine, Technology & Data Science, Education & Community Engagement, and Business & Industry. Table 3 also summarizes some examples of problems to address, potential collaborators, and solutions. The narrative following the table describes some examples of IDCR in which I have participated (Technology & Data Science) and illustrates how each of the strategies for success described in the previous section is used.

As an example of a progression of IDCR projects related to Technology and Data Science, I have collaborated with Teena Murray, a high-performance coach with 20+ years of experience. She has worked with athletes at the Collegiate level, in the NBA and NHL, and with USA Women's Hockey; she is currently with USA Soccer. Dr. Yong Gao, the most talented statistician and data analyst I know, was also a collaborator. We discussed several problems we wanted to solve, related to female athletes – a dramatically understudied population. Through the 3 examples that follow, we identified a problem, recruited the expertise needed, developed a collaborative culture and prioritized our ability to work together, provided a framework for solving problems, and lastly, identified KPIs (otherwise known as dependent variables).

We started with a simple physical profile of the USA women's hockey team (L. B. Ransdell & Murray, 2011). Teena was the performance coach for USA hockey, and we wanted to publish aggregate physical test data (e.g., vertical jump, long jump, 1RM front squat and bench press, front squat and bench press relative to body mass, pull ups, and body composition) from the U.S. team to help other countries seeking to join the USA and Canada at the highest echelon of women's hockey. From a skill and strategy perspective, teams were making in-roads. We wanted to provide information on these athletes' physical capabilities so they could advance to the next level of competition on the world stage.

Continuing along the lines of publishing physical profiles of elite female hockey athletes, we then examined physical performance test data from a "High Performance Camp" in Bratislava, Slovenia, where 204 elite female ice hockey athletes from 13 countries met to discuss hockey training strategies (L. Ransdell et al., 2013). In this study, athletes were tested on the vertical jump, long jump, 4-jump average, elasticity ratio (4-jump average/vertical jump), pull-up or inverted row, aerobic fitness, body mass, and body composition. Physical variables were examined relative to: (a) team success in major international hockey competition during the past decade (e.g., Group 1 = USA & Canada [Gold and Silver medal winners]; Group 2 = Sweden & Finland [Bronze medal winners]; Group 3 = all other participating countries), (b) age group (U18 and Senior/Open), and (c) player position (forward, defense, or goalie). Not surprisingly, compared to their less successful counterparts, athletes from the USA and Canada weighed more (yet had less body fat), had greater lower-body muscular power and upper-body strength, and higher aerobic capacity. Compared with U18 athletes, Senior/Open athletes had higher scores in lower-body power, pull-ups, and aerobic capacity. Interestingly, no statistically significant differences existed by player position.

After addressing a series of questions related to elite female hockey athletes, we turned to using technology and Catapult data to longitudinally examine player game data for a perennial powerhouse women's basketball team (0.817 win percentage) over a 4-year period (L. B. Ransdell et al., 2019). We examined workload (e.g., PlayerLoad, PL.min^{-1}, high inertial movement analysis [high-IMA], and jumps) by (a) season, (b) player position, and (c) game outcome (wins vs. losses). Important findings included that: (a) jumps increased across the 4-year period (indicating that training improved game capacity to jump); (b) PL.min^{-1} was higher for guards compared to posts (indicating that practice loads and games should be monitored and adjusted accordingly), and that high-IMA was higher in losses compared to wins (possi-

Table 3: *Examples of Interdisciplinary Collaboration & Research in Kinesiology*

Area of Collaboration	Potential Collaborators	Problem to Address	Solution
Health & Medicine	Exercise Physiologist, Data Scientist, Engineer, Sport Sociologist	Improve sleep & recovery habits of athletes Bigalke et al., 2025	Use sleep monitoring devices to measure sleep quality and quantity and how that relates to performance; could also measure HR variability, resting HR, and body temperature
	Biomechanist, PT/OT, Engineer, Psychologist, Motor Movement Specialist	Recover mobility after a stroke Calafiore et al., 2021	Develop an exoskeleton to restore mobility, improve muscle activation, and enhance quality of life
Technology & Data Science	Biomechanist, Exercise Physiologist, Sport Scientist, Psychologist, Sport Philosopher	Lower injury rate & burnout and improve athlete performance Eitzen & Yetis-Bayraktar, 2021	Measure workload with wearable sensor; adjust training accordingly; add force sensors to gather information about shock impact
	Biomechanist, Computer Scientist, Physical Therapist, Athletic Trainer	Prevent ACL tears Schulc et al., 2024	Use automated video analysis to identify biomechanical patterns associated with ACL injury
	PT/OT/Rehab, Virtual Reality Experts, Neuroscientists	Reach rural patients and gamify PT environment Bateni et al., 2024	Use VR with patients to gamify PT experience, and enhance motivation and adherence
Education & Community Engagement	Exercise Scientist, Community Planner, Epidemiologist, Adaptive PE Specialist	Study walking and cycling patterns and accessibility Baraka-Munyaka & Mhlongo, 2023	Use smartphone/devices and geolocation to study trail use; improve urban planning for walkable/bikeable neighborhoods
	PE Student Teachers, PE Teachers, Adaptive PE Teachers, Strength and Conditioning Specialists	Need more practical experience for student teachers Egan et al., 2024	Partner with area schools to bring children to colleges to work with aspiring PE teachers
Business & Industry	Public Health, Tribal Nations, Non-Profit Organizations, Health Promotion Specialists	Needs analysis to determine most important health equity issues in Northern Arizona Sabo et al., 2020	Surveyed 136 non-profit health organizations and tribal nations about health challenges; recommended infrastructure & collaboration to address top 10 health issues

bly indicating a frenetic reaction to losing, or indicating that an opponent with high-level skills and fitness demanded more effort). Findings can also be used to set expectations for the player and the team regarding game workload.

The aforementioned examples are proof positive that combining individual expertise and passion for a specific area can move the needle beyond what any one individual can accomplish. The combination of our expertise enabled us to publish papers that advanced female athletic performance and sport science.

Future Directions for IDCR

This paper would not be complete without including some future directions for IDCR. These examples are based on my

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Table 4: *Potential future strategies for enhancing IDCR and solving complex problems*

Type of Analytic Strategy	Uses	Strengths of Strategy	Challenges of Strategy
Use AI to enhance IDCR team success	Assign roles, responsibilities, outcomes of project based on personalities, strengths, and skills of team members	Saves time; enhances creative solutions	AI doesn't know team members
Analytic Hierarchy Process (AHP) Li et al., 2024	Organize and analyze complex decisions using math and psychology; weight decision criteria through pairwise comparisons	Saves time; enhances creative solutions	Inconsistency in dealing with complex interactions among criteria
Analytic Network Process (ANP) Li et al., 2024	Extends AHP in analyzing interdependence among elements	Suitable for more complex decisions	Pairwise comparisons can be time consuming & cognitively demanding
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Li et al., 2024	Given a finite set of solutions, identifies solutions based on geometric distance from the ideal solution	Good for linear decisions	Limited efficacy for interdependent decision criteria or with feedback loops

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own experiences in Kinesiology over the past 30 years and from reading several papers on IDCR. First and foremost, we need to continue examining the best ways to teach our students to think about their specialization areas, as well as how to conduct and participate in IDCR. This will take a village, with a healthy dose of intellectual humility and work to understand all of the disciplines that encompass Kinesiology.

Second, if we return to the top problems in Kinesiology identified at the beginning of this paper, conducting research to address them from an interdisciplinary perspective would be immensely beneficial. How do we lessen our identity crisis? How can we make our programs and discipline more sustainable? Can we operate more efficiently in this climate of funding and resource constraints? Are there ways we can enhance clarity around professional pathways for our students? Are there ways to advance the teaching profession and facilitate enhanced physical literacy in a world that increasingly relies on technology and a sedentary lifestyle?

Lastly, I would advocate for studying ways to utilize Artificial Intelligence to enhance our field.

Conclusions

No single discipline holds the key to improving human health. Interdisciplinary collaboration and research are essential to move our world forward. Using physical activity as a hub for improving health enables individuals from Kinesiology to shine and collaborate to improve life expectancy AND quality of life. It is important to remember that "Interdisciplinary success does not just happen when a group is placed together. It requires commitment from everyone and solid direction from leaders;" in addition, we are reminded that "The true power of interdisciplinary research lies not in merging disciplines into one, but in fostering the kind of enthusiasm and interaction that allows each discipline to inform and enrich the others" (Lane & Kreider, 2025, p. 1). It is my hope that this paper provided some inspiration, ideas, and strategies for enhancing IDCR within Kinesiology.

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WSKW Chronicles

2025 WSKW Conference Abstracts

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Keynote Presentation: Teamwork Makes the Dream Work: Strategies for Successful Interdisciplinary Collaboration in Kinesiology

Lynda Ransdell, Boise State University

E.C. Davis Lecture: E.C. Davis: Why Character Matters

Sharon K. Stoll, University of Idaho

Broten Young Scholars Lecture: Facilitators of and Barriers to Physical Activity Promotion among Physical Therapists who Treat Clients with Neurological Conditions: A Qualitative Study Informed by the Theoretical Domains Framework

Winston Kennedy, Northeastern University

ABSTRACTS

Healthy Active Lifestyles for People with Intellectual Disabilities: Model Demonstration Development and Implementation in Rural Communities

Erik Luvass, Olivia Lebens, Isabella Gilmore, Haley Sprague, & Emily Pearson (University of Idaho Center on Disabilities and Human Development)

PURPOSE: The University of Idaho Center on Disabilities and Human Development (CDHD) is Idaho's University Center for Excellence in Developmental Disabilities (UCEDD). With a federal mandate to provide disability training, services, and technical assistance, one model demonstration service called the Healthy Active Lifestyles (HAL) Project addresses the health and wellbeing of people with disabilities in rural communities. **CURRENT KNOWLEDGE & UPDATES:** It is not uncommon for adults with disabilities to experience chronic health conditions and mental health issues because of limited physical activity of sedentary lifestyles (Graham et al., 2008). People with intellectual and developmental disabilities (I/DD) are more susceptible to both physical and mental distress due to a lack of opportunities in their communities (Fox et al., 2014). Data collected by the Centers for Disease Control and Prevention support this current trend. The Healthy Active Lifestyle (HAL) Project at the CDHD applies faculty expertise from Movement Sciences and Nutrition Sciences to increase the health and wellbeing of adults with I/DD living in rural Idaho through three community-based programs. HAL Movement in the Park provides weekly inclusive fitness opportunities, Healthy Cooking Series offers cooking skill and nutrition

education, and NatureFit Adventures leverages the mental health benefits of nature engagement to combine physical activity, socialization, and independent living skills. Led by student trainees in the CDHD's Interdisciplinary Training Program, HAL program participants engage in their community, develop friendships, and build skills for healthy living. **FUTURE FORECASTS:** This presentation discusses the development and implementation of the HAL programs model as a unique interdisciplinary and multi-sector model for community health. With volatility in the current and future projected federal funding landscape, programs that address the health equity of people with disabilities may become scarcer and necessitate creative partnerships to prevent public health decline. **IMPLICATIONS:** Key partnerships in the HAL program model's success are highlighted along with strategies for program sustainability and community impact. Recommendations for similar implementations in rural communities across the state of Idaho are addressed in an audience-engaged discussion. Educators and practitioners in wellness and kinesiology, and the community connections they hold, will be integral to this effort. **CONCLUSIONS:** Recent challenges to traditionally supportive rhetoric about and services for people with disabilities pose significant barriers to health service provision. It may become incumbent upon disciplines not traditionally serving people with disabilities to work together to support the health and wellbeing of this population.

Streaming Success: Using Asynchronous Lecture Videos to Improve Equity, Engagement, and Outcomes in Large Enrollment A&P Courses

Van "DocDoc" Whaley (University of Nevada, Las Vegas)

ABSTRACT: Large-enrollment service courses in kinesiology, such as Human Anatomy & Physiology I & II, often challenge students due to the complexity of content and diverse learning needs. This presentation explores how asynchronous, manually corrected captioned lecture videos strategically embedded within Canvas can improve access, equity, and learning outcomes for over 2,500 students annually. By replacing outdated videos with more engaging, accessible, and updated content, greater student success was supported and the needs of working, first-generation, and neurodiverse learners were addressed. This teaching strategy addresses current trends in hybrid learning and technological equity, especially in post-pandemic higher education. Fall 2024 saw a 160,000-minute increase in video engagement compared to the previous year, with students praising the clarity, humor, and usefulness of the new content. These outcomes align with UNLV's Top Tier 2.0 goals of improving retention and closing graduation gaps. The purpose of this presentation is to share scalable, inclusive strategies for developing digital instructional materials. Attendees learn how to balance accessibility, student engagement, and academic rigor while avoiding common pitfalls in video design. **PURPOSE, BACKGROUND & RATIONALE:** Asynchronous learning has emerged as a powerful tool in higher education, particularly in large-enrollment foundational science courses. The rationale behind this work is grounded in the need to improve accessibility, engagement, and knowledge retention for diverse student populations. Given the intense rigor of A&P and the large student volume at UNLV, the integration of high-quality, instructor-produced video content addresses disparities in student preparation and study practices. **CURRENT KNOWLEDGE BASE:** Data collected through Panopto analytics showed high engagement with the new video resources. Student feedback collected from emails and evaluations confirmed improved clarity and connection to the material. The videos use updated pedagogy, captioning, and presentation tools such as iPad annotations and publisher-based imagery to enhance clarity and accuracy. The content is aligned with accessibility guidelines and reviewed by the Disability Resource Center. **FUTURE FORECASTS:** The next evolution in asynchronous video learning includes real-time

AI-driven closed captioning, learning analytics, and personalized learning modules. As institutions continue to embrace hybrid models, the demand for polished asynchronous content will increase. **IMPLICATIONS:** Without continual updates, instructional videos risk becoming obsolete or misaligned with course materials and learning outcomes. If high-quality asynchronous learning resources continue to be prioritized, retention and comprehension can increase, especially in STEM gateway courses. **CONCLUSIONS/TAKEAWAYS:** Asynchronous tools support diverse learners when designed with intention. High engagement and positive student feedback validate the approach. Videos should be reviewed and updated regularly to ensure relevance.

Athletes' Perception of Parental Influence

Fangyuan Li & Sharon K. Stoll (University of Idaho)

INTRODUCTION: Existing sport literature emphasizes that parental support can foster motivation and resilience, but over-involvement contributes to stress and burnout. Most studies focus on childhood and adolescence, while collegiate athletes offer more mature and comprehensive reflections. **PURPOSE:** To address how athletes perceive their parents' coaching behaviors and the influence these behaviors have on wellness and sport development. **METHOD:** The Parental Coaching Behavior Scale, a 26-item questionnaire, was piloted with 44 current and former athletes (41% female) in different team and individual sports at a Division I university. The instrument assesses perceived parental behaviors across competition, training, and everyday life contexts. Cronbach's alpha was 0.761. **RESULTS:** Preliminary data indicate that fathers' coaching was perceived as more beneficial than mothers' coaching across all settings. While only 6.8% of participants rated maternal coaching beneficial, 34.1% found paternal coaching helpful. However, fathers were also more frequently associated with harm. In practice, 36.4% of participants reported some level of harm from paternal coaching versus 18.2% for maternal coaching. U of I: IRB #25-095. **DISCUSSION:** While fathers tend to take a more active or directive role leading to greater perceived benefits, their role also has a higher risk of perceived pressure or harm. Mothers' coaching was generally seen as less influential, both positively and negatively, indicating a more neutral or less intensive role.

Student Wellness and the Student-Teaching Experience: A Critical Examination of Theory and Practice

Daniel Balderson (University of Lethbridge)

PURPOSE: This presentation examines the theory and practice related to student wellness and the student teaching experience. It highlights current literature associated with student wellness during this critical time and provides a review of wellness practices at post-secondary institutions. **CURRENT KNOWLEDGE BASE & UPDATES:** Student wellness at the post-secondary level in Canada and the United States shows alarming trends. The stressful environment students face can lead to many mental and other health challenges that can have lifelong or even life-threatening consequences. For pre-service teachers these stressors are multiplied during the student teaching process, especially when the student is experiencing challenges and the likelihood of a withdrawal is evident. This research is grounded in the theory of wellness as an important aspect of student success. **FUTURE FORECASTS:** Results vary in the ways programs that support student teachers, or other professional practica, provide wellness-related initiatives and assistance. While some have

formal procedures and policies to support students, others defer to broader university-wide wellness programs. **IMPLICATIONS:** Enhanced knowledge of this issue has the potential to provide awareness, best practices, and policy changes to ultimately help students have greater opportunity for success. **CONCLUSIONS:** Participants are invited to consider their institution's own practice and examine whether change is warranted and how best to support post-secondary students at this critical time.

I am the One: What Professionals with Physical Disabilities Can Teach You

Aubrey Shaw & Sharon K. Stoll (University of Idaho)

BACKGROUND/PURPOSE: Most scholars and teachers within adapted physical education are able-bodied individuals. Those who do have physical disabilities argue that the able-bodied, though well-meaning, have little personal understanding of physical disability. This presentation offers a different perspective of adapted physical education from a person with a physical disability and how that perspective could increase participation and scholarship in the field. **CURRENT KNOWLEDGE BASE AND UPDATES:** Michael Oliver, a disabilities scholar, argues that able-bodied people do not know the lived bodily experience of having a physical disability. He states the lived experience of disability offers insight and perspective that broadens research and teaching knowledge. We believe Oliver is correct since, within physical education, research is clear that students with physical disabilities are not physically literate, though they may be included. The upshot is few researchers and teachers with disabilities. **FUTURE FORECASTS AND IMPLICATIONS:** People with physical disabilities need to become scholars and teachers to role-model that physical disability is not a limitation to a full life of participation, play, and even competition. **CONCLUSIONS:** Adapted physical education and kinesiology need professionals with physical disabilities as scholars and teachers, as they provide a healthier perspective about the field through their own bodily experiences.

For the Love of the Run: Lessons Learned from the Mountain

Sam Lewis & Sharon K. Stoll (University of Idaho)

PURPOSE: The NCAA has verified that athlete mental health is presently in jeopardy. Their response is paid mental health professionals. The presenters argue that love of movement may be a solution. This oral presentation discusses the lessons learned from a professional runner and coach who chased the objective outcome, suffered a career-ending injury, found a place to heal, and learned to fall deeply in love with running. **CURRENT KNOWLEDGE BASE & UPDATES:** In athletics' shifting landscape, why should coaches and athletic departments invest in athlete holistic development when athletes transfer yearly chasing financial deals? The presenters argue that wellbeing is more important than money. Teaching a love of movement is difficult to accomplish in the current win-at-all-costs sport culture. A passion for sport is secondary and generally disregarded for the objective experience: the results, statistics, and numbers. Research from the Center for ETHICS at the University of Idaho has demonstrated that fostering a passion for movement requires an investment in the holistic, which is time-intensive. **FUTURE FORECASTS & IMPLICATIONS:** Coaching must be focused on the subjective experience in which athletes dialogue with their coaches about the joy of sport. Curriculum examples, podcast links, and coaching

materials are offered to give directions for success. **CONCLUSION:** Participants leave with an understanding of why it is imperative to help their communities find meaning in movement, how to navigate and balance objective and lived experiences in sport, and how to ensure joy is the foundation of these relationships.

Teaching with AI: Strategies for Effective Integration into Teaching & Assessment

Heather Van Mullem (Washington State University)

PURPOSE: Generative AI is transforming teaching and learning. AI tools have altered how students learn, impacted how faculty teach, and resulted in necessary modification of assessment strategies. **CURRENT KNOWLEDGE BASE & UPDATES:** Along with AI's ever-increasing presence, concerns about academic integrity and cheating persist. While AI detection software is plentiful, it is inconsistent and can be inaccurate, resulting in harm to students who are mistakenly accused of using AI to cheat. **FUTURE FORECASTS:** While concerns about AI, ethics, and integrity remain, businesses expect new graduates to understand how to use AI efficiently and effectively. **IMPLICATIONS:** Generative AI will continue to influence and impact education and other aspects of our lives. Employers expect graduates to understand how to use generative AI from day one in their job. Faculty must consider the role of AI in their classes and how they will help students understand how to use it ethically and with integrity as they prepare to complete advanced education and develop work-ready skills. **CONCLUSIONS:** This presentation explores strategies for creating a clear and effective AI course policy, shares examples of AI course policies, explores ways to engage students in meaningful conversations about using AI ethically and with integrity, and considers how AI can be meaningfully used by faculty to enhance assignment design and assessment.

The Role, Impact & Value of Kinesiology

Jafra D. Thomas (California Polytechnic State University, San Luis Obispo), Aubrey Shaw (University of Idaho), Sharon K. Stoll (University of Idaho), & Heather Van Mullem (Washington State University)

Presenters examine strengths and shortcomings of kinesiology research throughout history and explore challenges facing the field of kinesiology as it moves into the future. Areas of focus include socio-cultural issues, disability, philosophy, and ethics.

Facilitators of and Barriers to Physical Activity Promotion among Physical Therapists who Treat Clients with Neurological Conditions: A Qualitative Study Informed by the Theoretical Domains Framework

Winston Kennedy (Northeastern University)

Healthcare provider communication about physical activity leads to meaningful and sustained increases, yet physical therapists do not consistently promote physical activity for clients with neurological conditions. To understand what factors could support implementation strategies related to PTs promoting physical activity for clients with neurological conditions, a qualitative study

based on the Theoretical Domains Framework was performed. One-on-one online interviews were conducted in 2022 with 10 physical therapists licensed to work in the United States whose caseload included clients with neurological conditions. Responses about facilitators corresponded to personal, professional, and client-related factors. Barriers corresponded to professional and client-related factors. The findings suggest that the PT profession may benefit from including health promotion and community engagement curricular content, both in student training and in post-professional education.

Hecka Movement: An Afrocentric Approach to Embodied Wellness

Unique Shaw-Dismuke (California Polytechnic State University, San Luis Obispo)

PURPOSE: Kinesiology and wellness disciplines continue to advance powerful understandings of physical health and performance. Hecka Movement complements these insights by introducing an Afrocentric framework that centers ancestral wisdom, intuitive knowing, and spiritual alignment as essential components of holistic wellbeing, particularly for Black communities. **METHODS:** Grounded in the Afrocentric criteria developed by Mazama, this approach affirms the African experience as central to all inquiry and emphasizes that not everything that matters is measurable. It values the body and its intuition as a source of knowledge, offering a decolonizing lens through which to reimagine wellness. **RESULTS:** This presentation explores the author's work as a holistic movement practitioner, particularly how incorporating ancestral frameworks can enrich kinesiology by honoring the body not just as a physical site, but as a spiritual and cultural one. **CONCLUSION:** Reclaiming movement as a sacred, Afrocentric act fosters both individual healing and wellness as well as collective liberation.

Assessment in Action: Program Assessment Through Student Poster Presentations

Karen M. Appleby, Elaine Foster, Maren Hunter, & Tayler Elizondo (Idaho State University)

Program-level assessment is a critical component of effective teaching. **PURPOSE:** This presentation presents a unique and engaging program-level assessment model implemented at Idaho State University where students in the Human Performance and Sport Studies Department major in Sport and Exercise Science, Outdoor Education, or Sport Management. **CURRENT KNOWLEDGE BASE & UPDATES:** The program-level assessment model is aligned with current best practices and continues to evolve to elicit meaningful program data. Examples of program-level student learning outcomes, signature assignments that align with these outcomes, and strategies to facilitate the assessment process are shared. **IMPLICATIONS:** This model engages students in meaningful course-level signature assignments followed by the opportunity to share these assignments at a department-level professional poster presentation. Faculty can assess student learning both formatively and summatively. **FUTURE FORECASTS:** Program-level assessment will continue to evolve as student and industry needs change and as stakeholders require data about program effectiveness.

Teamwork Makes the Dream Work: Strategies for Successful Interdisciplinary Collaboration in Kinesiology

Lynda Ransdell (Boise State University)

The field of kinesiology has evolved in many ways, from preparing physical educators to preparing pre-rehabilitation sciences students. Throughout this evolution, kinesiology has led the charge in developing interdisciplinary departments that engage professors in a wide variety of academic disciplines. Given the need to continue to grow interdisciplinary collaborations and the prestige and respect for the field of kinesiology, it is important to develop interdisciplinary and interprofessional collaborations. This presentation defines key terms, proposes four dimensions for collaboration in kinesiology and provides examples of each, highlights challenges and successful aspects of interdisciplinary collaboration, and suggests areas for future research.

Reflections on Higher Education: Building a Career in Academia Today

Pete Van Mullem & Heather Van Mullem (Washington State University)

PROPOSAL: Higher education is facing numerous challenges today, including declining enrollment, funding pressure from federal and state governments, questions about the value of a college degree, and the implementation of AI. Faculty continue to navigate these challenges while striving to find their professional footing in the classroom and in scholarship. **PURPOSE:** In this session, WSKW Past-Presidents reflect on their experiences in higher education and offer insight on how to navigate the challenges of today while building a career in academia, specifically in kinesiology and wellness. **CURRENT KNOWLEDGE BASE & UPDATES:** Reflective practice informs current practice and guides future decision-making. **IMPLICATIONS:** WSKW Past-Presidents are leaders in kinesiology and wellness, with experiences in teaching, research, administration, mentorship, and service. **CONCLUSIONS:** Using established prompts, panelists provide responses to questions related to their experiences in higher education, how to navigate challenges today, and what they envision for the future of kinesiology and wellness.

Hecka Movement

Unique Shaw-Dismuke (California Polytechnic State University, San Luis Obispo)

Hecka Movement is a heart-centered practice that combines breathwork, guided visualization, and meditative movement to align the body and energy. Inspired by yoga asana but rooted in an Afrocentric framework, this class honors the body as a spiritual and cultural site. It invites participants, especially from Black communities, to connect with the magic and medicine of the body and move intentionally to embody healing. With attention to mind, body, and spirit, Hecka Movement offers a holistic approach to wellness, grounded in cultural truth and collective care.

E.C. Davis: Why Character Matters

Sharon K. Stoll (University of Idaho)

The purpose of this keynote is to review E.C. Davis's professional life, including his service to his country, his profession through teaching and research, and his discipline of physical education, in which character mattered and directly affected all of us who study, teach, research, and learn. Selected early historical figures are reviewed and their influence on Davis and the field is considered. The focus is clear: character does matter.

Readings from the National Baseball Poetry Festival (NBPF)

David Lott (Montgomery College), Rex Arrasmith (Lesley University), & Matthew Lawrence (Warren Wilson College)

A series of baseball-related poems will be read.

Body Fat Percentages in Cal Poly San Luis Obispo Students: A Comparative Analysis with NHANES Data

Melissa Cline, Andres Rocha Jayasinha, Andie Franco, Ava Emmerling, Lexi Yaghoubi, & Eric Benson (California Polytechnic State University, San Luis Obispo)

BACKGROUND: The Body Mass Index is widely used as a health indicator; however, it cannot differentiate between fat mass and fat-free mass. In young adults, especially those with active lifestyles, BMI may inaccurately reflect true body composition. **PURPOSE:** To compare DXA-derived fat mass percentages of healthy Cal Poly SLO students aged 18 to 25 with national reference values from NHANES, and to assess the impact of COVID-19 on body composition. **METHODS:** DXA scans were used to assess body fat percentages in Cal Poly students. Data were compared to NHANES reference values for the same age group. Pre- and post-COVID data were analyzed to evaluate changes in fat mass. **RESULTS:** Pre-COVID, female Cal Poly students averaged 30.08% body fat, while males averaged 19.00%. NHANES data for similarly aged individuals report averages of 37.75% for females and 25.32% for males. Although Cal Poly students experienced a 3% increase in fat mass post-COVID, they still exhibited significantly lower fat mass than national averages. **CONCLUSION:** Despite having BMIs within the normal range, Cal Poly students exhibit lower fat mass than national norms, likely due to the university's fitness-oriented culture. This study reinforces the need to move beyond BMI and incorporate direct measures of body composition in preventive care practices targeting young adults.

Coach Retention: Implications for the Student-Athlete Experience

Pete Van Mullem (Washington State University)

PURPOSE: Due to stress, costs, and conflicts, the average tenure of a K-12 coach is estimated to be 3 to 5 years. Coach turnover affects athletes' experiences and has a long-term impact on the success of athletic programs. **CURRENT KNOWLEDGE BASE:** When youth participate in positive sport experiences, they gain confidence and develop life skills such as teamwork, leadership, communication, social skills, emotional skills, and work ethic. The coach's ability and behavior will determine the athlete's experience under their guidance. **FUTURE FORECASTS:** Coach retention is often due to a lack of experience or training. Thus, administrators need to evaluate

qualified coaches on established standards during hiring and have a plan in place to develop coaches based on their readiness to teach and lead. **IMPLICATIONS:** A coach who feels more confident in their ability to teach sports skills, plan practices, and connect with youth has a greater chance of producing positive youth sport experiences. **CONCLUSION:** This presentation discusses the role of the administrator in evaluating coach readiness and providing coach development activities, outlines the development of a coach readiness tool, and describes the development of a pilot study through a community-engaged research grant.

The Rate of Academic Clustering Among U SPORTS Athletes at Canadian Universities

Steve Miller (Saint Mary's College of California) & Chris Chard (Brock University)

BACKGROUND: Previous work in the United States has shown that athletes in colleges and universities, especially those in high-profile programs, tend to choose academic majors not because of interest but because they do not interfere with athletic pursuits. **PURPOSE:** To examine the rate of academic clustering among U SPORTS teams at Canadian universities and to examine the reasons why athletes choose to cluster. **METHODS:** Phase I examined academic majors of male and female athletes from U SPORTS programs in 59 universities and 10 sports using data from athletics websites. Phase II involved in-depth interviews with members of the team that had the highest rate of clustering. **RESULTS:** Compared with previous U.S. investigations, rates of academic clustering were relatively low among athletes competing in U SPORTS programs. Interviews suggested that participation in intercollegiate athletics does not interfere with or undermine academic pursuits. **CONCLUSION:** Despite the growing popularity and attention paid to U SPORTS in Canada, academic clustering does not appear to be a major problem.

Program Leader Perspectives on the Inclusion of Students with Physical Disabilities in Campus Physical Activity Programs: A Case Study

Elaine Foster & Tanslee Kirkham (Idaho State University)

INTRODUCTION/PURPOSE: Campus physical activity spaces and activities are central to most universities. For students with physical disabilities, accessing these spaces and activities can be challenging for many reasons. This case study examines the inclusion of students with physical disabilities in physical activity on one university campus from the perspectives of those who oversee physical activity programs. **SUBJECTS & METHODS:** Semi-structured interviews were held with leaders for four different campus physical activity programs. **RESULTS:** Each leader had unique ideas and perspectives on how accessible their programs are. Three leaders indicated that they would make accommodations if requested, while the fourth leader was actively trying to recruit students with physical disabilities to the program. **DISCUSSION/CONCLUSIONS:** The results demonstrate the unique perspectives and attitudes physical activity leaders have regarding inclusion of students with physical disabilities. Further investigation will include discussions with the director of Disability Services and with students who have physical disabilities.

Enhancing Mobility in Older Adults: A Pilot Home-Based tDCS and Motor Imagery Intervention

Clayton W. Swanson, Todd M. Manini, Kimberly T. Sibille, & David J. Clark

BACKGROUND: Falls are a leading cause of injury and mortality in older adults, highlighting the need for accessible interventions to enhance mobility and reduce fall risk. **METHODS:** Thirty-two fall-prone older adults were randomly assigned to receive active or sham frontal transcranial direct current stimulation during six self-administered motor imagery sessions over two weeks. Feasibility and acceptability were assessed through recruitment, retention, adherence, and post-session ratings. Mobility outcomes included the mini-Balance Evaluation Systems Test and Timed Up and Go tests under single- and dual-task conditions. **RESULTS:** The intervention demonstrated strong feasibility and acceptability, with anticipated enrollment, high protocol adherence, and positive user feedback. Significant improvement in balance scores was observed, and the active tDCS group showed moderate improvement in dual-task Timed Up and Go performance. **CONCLUSION:** This home-based motor imagery plus tDCS program is feasible, well tolerated, and shows promise for improving mobility under cognitively demanding conditions.

Stay in the Game: Building Support Systems in Coaching

Pete Van Mullem (Washington State University)

PURPOSE: To achieve longevity in coaching, coaches must build support systems. Coaches face numerous challenges that limit their tenure, including burnout, pressure to win, a lack of opportunities for advancement, and misalignment of organizational values. **CURRENT KNOWLEDGE BASE:** Coach turnover affects the student-athlete experience and the sustainability of athletic programs. Researchers have examined how building relationships with all stakeholders can improve coaching practice and coach longevity. **FUTURE FORECASTS:** The challenges coaches face to stay in coaching are not going away. Coaching educators and scholars are therefore working to help coaches manage these challenges through support systems that enhance resilience, wellbeing, and effectiveness. **IMPLICATIONS:** Developing a foundation of support is an actionable step the coach can take to garner support from athletes, coaching peers, the organization, and the broader community. **CONCLUSIONS:** Using evidence-informed practices in coach development, kinesiology and wellness professionals can serve as coach developers to help coaches build support systems with all stakeholders.

Little Ideas Can Make a Big Difference in the Field

Aubrey Shaw & Sharon K. Stoll (University of Idaho)

Students and faculty generate research to support the profession and improve humanity. Complex methods and inferential statistics often drive research, but descriptive research is also powerful. **PURPOSE:** To discuss how small ideas can change practice and promote research. **CURRENT KNOWLEDGE BASE & UPDATES:** Twenty percent of the U.S. population is physically disabled. The presenters asked whether that representation appears pictorially in SHAPE America's two research magazines. A rubric was developed to measure the pictorial incidence of people of color and people with physical disabilities in a random sample over a 5-year period. **FUTURE**

FORECASTS/IMPLICATIONS: Gender and race were represented, but people with physical disabilities were not. A research abstract was submitted, accepted for oral presentation, and published. **CONCLUSION:** Small ideas and descriptive statistics are meaningful. This study led to changes in how people with physical disabilities are perceived in movement settings.

Student Poster Session

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Faculty Poster Session

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1	"It's Love & Hate Relationship": Undergraduate Student Experiences with Online Learning	Heather Van Mullem
2	Convenient Inclusivity: Examining the Social Media of a Disc Golf Pro Tour (DGPT) LGBTQ+ Athlete	Heather Van Mullem & Kirby Boehm
3	Kinesiology Students' Perspectives on Sports-Based Disability Simulations: A Qualitative Exploration	Min Kim, Yeonhak Jung, Dalhyun Moon, & Boung-Jin Kang
4	Motivation in Motion: Impact of Heart Rate Monitors on Motivation in Movement Class	Erik Luvaas, Maya Hamilton, Isabella Gilmore, & Abril Correa
5	Turning Performance in Older Adults: The Role of Cognitive Function and Cortical Thickness	Clayton W. Swanson, Anthony Gruber II, Adam J. Woods, Dorian K. Rose, Rachael D. Seidler, & David J. Clark

#	Poster Title	Author(s)
6	Kids and Kinesiology: Service Learning in Motor Development	Laura Petranek
7	Volunteer Coaches' and Team Parents' Reasons for Not Returning to a Sports-Based Youth Development Program	Nicole Bolter
8	Physical Fitness and Social Maturity in Adolescents: The Mediating Role of Athlete Identity	Yeonhak Jung & Minhyun Kim

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Undergraduate Student Experiences with Online Learning

Heather Van Mullem (Washington State University)

PURPOSE: Online instruction has become more prevalent since the COVID pandemic. The purpose of this study was to better understand undergraduate student experiences with online learning. **METHOD:** Undergraduate students (N = 265) across majors enrolled in general education and program-specific courses participated in a survey about their online learning experiences. Students were asked five Likert-scale questions and one open-ended question about perceived experiences with online learning. **RESULTS:** Students' experiences with online classes were not correlated with academic year in school or with college generation status. Cumulative GPA did not predict students' experiences with online courses. Analysis of student comments revealed four themes: convenience of online coursework, lack of effort to learn online course material, frustration with disorganized online course design and its impact on learning, and feeling disconnected from classmates and faculty. **DISCUSSION:** Improved understanding of student experiences with online learning can help faculty identify and implement strategies to better engage students and improve their learning experience.

Convenient Inclusivity: Examining the Social Media of a Disc Golf Pro Tour (DGPT) LGBTQ+ Athlete

Heather Van Mullem (Washington State University) & Kirby Boehm (Lewis-Clark State College)

PURPOSE: Social media plays a crucial role in shaping how sports fans engage with athletes. This study examined how the disc golf community interacted with a transgender professional disc golf athlete, Natalie Ryan, on the Instagram page of her former sponsor, Neptune Disc. **METHOD:** To explore the prevalence of cyberbullying, 1,240 comments across 200 posts on Neptune Discs' Instagram page were analyzed. Cyberbullying was defined as content that was transphobic, homophobic, threatening, sexist, sexually explicit, or expressed lack of support. **RESULTS:** Ryan was featured 234 times. Cyberbullying was present, with 17.95% of comments identified as transphobic and 20.51% expressing lack of support. However, the most common sentiment was

encouragement, with 50% of comments showing support. **DISCUSSION:** Despite broader hostility toward transgender athletes, Neptune Discs created a space that showcased support for Ryan and other members of the LGBTQ+ community. The company's efforts serve as a model for how sport brands can create campaigns that champion inclusivity.

Kinesiology Students' Perspectives on Sports-Based Disability Simulations: A Qualitative Exploration

Min Kim (Sam Houston State University), Yeonhak Jung (California State University, Northridge), Dalhyun Moon (California State University, East Bay), & Boung-Jin Kang (Elizabeth City State University)

PURPOSE: Disability simulations have been employed in kinesiology programs to provide students with experiences they may not encounter in daily life. Framed in experiential learning theory, this study examined kinesiology undergraduate students' experiences in sport-based disability simulations. **METHODS:** Participants were 33 undergraduate kinesiology students enrolled in an adapted physical activity course. Data were collected via focus-group interviews, reflection papers, and field notes. **RESULTS:** Four themes emerged: expectations being challenged, eye-opening realizations and emerging curiosity about people with disabilities, changed outlooks toward disability, increased self-awareness and gratitude, and professional growth. **DISCUSSION:** Findings indicate that sport-based disability simulations foster transformative learning experiences that challenge initial expectations, alter attitudes toward people with disabilities, and enhance empathy.

Motivation in Motion: Impact of Heart Rate Monitors on Motivation in Movement Class

Maya Hamilton, Isabella Gilmore, Abril Correa, & Erik Luvaas (University of Idaho Center on Disabilities and Human Development)

INTRODUCTION: People with disabilities engage in disproportionately less physical activity and have more weight-related comorbidities. Community-based inclusive physical activity programs can provide structured opportunities for physical activity and socialization. **METHOD:** Movement in the Park is a free 25-minute inclusive group fitness class offered by the UI Center on Disabilities and Human Development's Healthy Active Lifestyles Initiative. During a five-week period, heart rate monitor wristbands were introduced and participants' heart rates were tracked during each session. **RESULTS & DISCUSSION:** An increase of moderate-vigorous exercise was observed as measured by heart rate zones calculated from age-based maximum heart rate. This suggests heart rate biofeedback may contribute to increased motivation and effort during group exercise participation. Instructors also observed increased participant encouragement and interaction after introduction of the monitors.

Turning Performance in Older Adults: The Role of Cognitive Function and Cortical Thickness

Clayton W. Swanson, Anthony Gruber II, Adam J. Woods, Dorian K. Rose, Rachael D. Seidler, & David J. Clark

BACKGROUND: Neurodegenerative aging affects cognition, brain structure, and mobility, including walking. Turning while walking is a frequent and neuromechanically complex task that has received less attention despite its relevance to daily functioning and fall risk. **PURPOSE:** To investigate whether turning performance in older adults was associated with cognitive function and cortical thickness, and whether cortical thickness mediates this relationship. **METHODS:** Forty-one older adults completed 180-degree and 360-degree turns at natural and fast paces while wearing inertial sensors. Executive cognitive function was assessed using a computerized battery. Cortical thickness was measured with structural MRI. **RESULTS:** Poorer cognitive performance was significantly associated with longer 360-degree turn durations and slower fast-pace turn velocities. Thinner frontal gyri correlated with slower and longer turns. Bayesian mediation analyses showed no indirect effects; cognitive function directly predicted turning. **CONCLUSION:** Cognitive performance and frontal cortical thinning are independently linked to poorer turning in older adults.

Kids and Kinesiology: Service Learning in Motor Development

Laura Petranek (Boise State University)

PURPOSE: Service learning can have a strong impact on student engagement by combining hands-on experiences with reflection. This presentation shares a service-learning experience created in an undergraduate motor development course. **CASE:** Working closely with a service-learning program and an early child care center on a university campus, an intentional experience was developed in which undergraduate students learned how to administer the TGMD-3 and planned developmentally appropriate activities following the SKIP program for ten kindergarteners. **SIGNIFICANCE:** Through reflection, students made connections between course content and real-life application. It was observed through reflections and assignments that students' understanding and confidence improved throughout the semester. **CONCLUSIONS:** This experience provided students an authentic environment in which to work with young children and apply concepts learned in class in real time.

Volunteer Coaches' and Team Parents' Reasons for Not Returning to a Sports-Based Youth Development Program

Nicole Bolter (San Francisco State University)

Junior Giants is a free, non-competitive sport-based youth development program that offers baseball and softball to children ages 5 to 14. This study qualitatively explored reasons why coaches and team parents may choose not to return to Junior Giants. Participants included a subset of 135 coaches and 81 team parents from a larger sample who indicated they did not intend to return to the program the following year. Although most coaches and team parents intended on returning, those who did not were asked to elaborate in an open-ended follow-up question. Thematic analysis created several themes across participants, including preference to be a spectator, child not returning, need

for more support, and lack of organization and communication. Results provide opportunities for reflection and potential changes to future programming.

Physical Fitness and Social Maturity in Adolescents: The Mediating Role of Athlete Identity

Yeonhak Jung (California State University, Northridge) & Minhyun Kim (Sam Houston State University)

Adolescence is a pivotal stage of human development characterized by rapid physical, emotional, and social changes. This pilot study explored the relationship between physical fitness and social maturity among adolescents, with particular attention to athletic self-identification. A sample of 187 adolescents aged 11 to 17 who self-identified as athletes or non-athletes participated. Participants completed FitnessGram assessments, a standardized social maturity scale, and a self-identification athleticism questionnaire. Correlation analyses showed a positive relationship between fitness components and social maturity, and a significant positive correlation between FitnessGram components and self-identified athleticism. A mediation analysis showed that athletic identity partially mediated the relationship between one-mile run performance and social maturity, but not push-ups and curl-ups. These findings suggest that physical education programs that simultaneously enhance physical competence and cultivate athletic identity may contribute to greater social maturity among students.

From Risk to Resilience: How Youth Mentoring Improves Outcomes and Its Implications for Kinesiology-Based Wellness Programs

Joshua Eng (California Polytechnic State University, San Luis Obispo)

This literature review examined the impact of mentorship on at-risk youth populations, particularly those affected by socioeconomic hardship, single-parent households, or adverse social environments. Grounded in resiliency theory, it explored how mentorship can benefit from kinesiology-based programs focused on academic, emotional, and behavioral resilience. Studies were selected for their empirical focus on structured educational interventions or mentoring programs and their relevance to physical activity as an approach to youth development. Three key findings emerged: relational attunement and goal setting consistently improve resiliency outcomes, structured theory-based interventions yield lasting academic and behavioral benefits, and integrating physical activity into mentorship programs enhances coping mechanisms and overall wellbeing. Future research should explore how well kinesiology-based school and community initiatives engage vulnerable youth using evidence-informed strategies.

Role of Physical Activity in Managing Mental Health Disorders

Aastha Gurung (California State University, San Bernardino)

This literature review examined the current literature regarding the effects of physical activity on mental health, especially anxiety, depression, and stress. Electronic searches were conducted using PubMed and JSTOR. Findings across selected studies suggest a positive relationship between physical

activity and health-related quality of life, emotional reactions, stress responses, life satisfaction, happiness, and adjunctive treatment outcomes in adolescents with depression and anxiety. The review concludes that physical activity plays an important role in mental health across populations, while also noting that more research is needed to provide deeper understanding.

Addressing Caregiver Occupational Stress: A Rapid Literature Review of Mindfulness-based Wellness Interventions Strategies and Assessment Tools

Sherry Lin (California Polytechnic State University, San Luis Obispo)

INTRODUCTION: Caregiving is a physically and emotionally demanding occupation. **PURPOSE:** To review research evaluating mindfulness-based worksite wellness programs for caregivers and to summarize evidence of reliability and validity for two assessment tools: the Zarit Burden Interview and the Kingston Caregiver Stress Scale. **METHODS:** Articles published between 2010 and 2025 were reviewed. **RESULTS:** Twelve articles met inclusion criteria. Meta-analytic findings suggest mindfulness-based worksite wellness programs yield small-to-moderate reductions in caregiver stress and depression symptoms and may improve emotional resilience, though they provide minimal mitigation against objective burden such as time constraints. Both assessment tools showed acceptable reliability and validity. **CONCLUSION:** Kinesiology wellness professionals should pair organizational supports with mindfulness-based wellness interventions for caregivers.

Self- and Other-efficacy Changes in New Personal Training Relationships over the Course of a Twelve-week Training Program

Jared Medeiros (Boise State University)

INTRODUCTION: In personal training, the quality of interpersonal relationships between clients and fitness professionals can significantly impact motivation, adherence, and outcomes. **PURPOSE:** To investigate changes in trainees' other-efficacy and trainers' self-efficacy over the course of a training program. **METHODS:** Trainers and trainees complete surveys assessing self- and other-efficacy at the beginning, midpoint, and end of a twelve-week training program. Repeated measures ANOVA is used to assess change over time. **RESULTS:** The projected expectation is a significant increase in other- and self-efficacy at the end of the program compared with baseline scores. **CONCLUSION:** This examination provides opportunities for trainers to improve the overall experience for trainees by creating increased awareness of the trainee's perspective.

Improving Minor Burn Knowledge: A Randomized Pilot Trial of Teach-to-Goal Versus Brochure-based Education

Laura Byrne (California Polytechnic State University, San Luis Obispo)

Minor burns may account for as much as half of burn-related emergency room visits annually. **PURPOSE:** To explore the feasibility of the teach-to-goal method in promoting health literacy for managing minor burns in adults. **METHODS:** A randomized pre-post knowledge-check design was used. An educational brochure on minor burn first aid treatment was developed and written at

a fifth-grade reading level. College student adults were randomly assigned to either a brochure-only or teach-to-goal group. **RESULTS:** Both groups showed substantial knowledge gains, though preliminary analysis suggested greater gains in the teach-to-goal group. **CONCLUSION:** Health education brochures with strong suitability can improve first aid knowledge, but the teach-to-goal method may produce greater gains, particularly for individuals with lower baseline scores.

A Brain-level Investigation of the Benefits of Physical Activity for Older Adults Experiencing Depression Symptoms

Bella Grant (Boise State University), Jet Taylor (University of Utah), C.J. Brush (Auburn University), & Mariane Bacelar (Boise State University)

Depression is a leading cause of disability worldwide, and in older adults it can lead to worse outcomes including higher mortality. This study investigated the association between self-reported physical activity and reward sensitivity in older adults experiencing depression symptoms. Twenty-nine older adults completed a gambling task used to elicit the Reward Positivity, a neural measure of reward sensitivity, along with the Yale Physical Activity Survey and the Geriatric Depression Scale. Contrary to predictions, lifestyle physical activity did not moderate the relationship between depression symptoms and Reward Positivity. Although physical activity has been shown to alleviate depression symptoms, more studies are needed to better understand the mechanisms explaining this association.

Creatine Supplementation to Increase Exercise Performance at Simulated Altitude

Duncan Hawe et al. (California Polytechnic State University, San Luis Obispo)

Exercise performance is significantly decreased at high altitude. Creatine supplementation increases exercise performance at sea level, but no published studies had examined its effects at high altitude. **PURPOSE:** To determine the effects of creatine supplementation on exercise performance at a simulated altitude of 3,800 meters. **METHODS:** Forty-seven healthy, physically active college students completed repeated sprint testing at sea level baseline and again after two days of double-blind supplementation with placebo or creatine while breathing a hypoxic gas mixture. **RESULTS:** Preliminary data indicated a decrease in exercise performance at altitude compared with sea level for both groups, but no clear difference in peak and mean power loss across sprints between groups. **CONCLUSION:** This appears to be the first study investigating the effects of creatine supplementation on exercise performance at simulated altitude.

Participation and Performance Variables During Standardized Versus High-autonomy Motor Skill Assessment Conditions for Autistic Children

Drew Jones (California State University, Chico)

Many autistic children demonstrate low scores in fundamental motor skill performance on standardized assessments and may experience challenges participating in such assessments. **PURPOSE:** To examine the influence of a high-autonomy condition versus the standardized condition of the

TGMD-3 on motor skill performance and participation variables among autistic children. **METHODS:** Fifteen autistic children completed both conditions using a within-subjects repeated-measures design. **RESULTS:** No significant differences were found between conditions for performance or fun. In contrast, the high-autonomy condition elicited significantly more skill attempts, particularly for object control skills. **CONCLUSION:** High-autonomy conditions may not change measured skill performance or fun, but they may increase participation through greater skill attempts.

Development of Cloze Tests in Spanish: A Pilot Tool for Strengthening Wellness Through Patient Education Materials

Giselle Martinez, Kaitlyn I. Kuan, & Emily Rodriguez (California Polytechnic State University, San Luis Obispo)

Reading grade-level formulas have limited accuracy, so patient education material comprehension should be tested directly before use. **PURPOSE:** To evaluate the feasibility of using the cloze procedure to determine comprehension of patient education materials written in Spanish. **METHODS:** Procedures from a prior dissertation study were replicated using two nutrition education materials on fiber. Cloze scores were cross-validated using open-response questions. **RESULTS:** Seven adults with varied Spanish literacy skills participated. Comprehensibility scores were equivalent across the two materials, and the full protocol took one hour to administer. **CONCLUSION:** The replication protocol was feasible to administer, and the pilot results underscored the need to directly test patient education material comprehension.

Motor & Soft Skill Development in 4 to 6-year-old Krav Maga Students

Abaigael Richards (Boise State University)

PURPOSE: Despite the growing popularity of youth martial arts, there is limited research on their developmental impact, particularly in modern systems like Krav Maga. This study explores whether regular participation improves motor skills and affective skills such as focus and self-control in children aged 4 to 6. **METHODS:** Children enrolled in a Krav Maga program participate in 16 weeks of training, with data collection every four weeks. During each collection point, children complete an obstacle course that is video-recorded and assessed with a rubric, while instructors and parents complete affective behavior assessments. **RESULTS:** The predicted expectation is that students will show improvements in both motor and affective skills over time. **CONCLUSION:** Data collection is ongoing, and preliminary results will be shared.

Mental Health in the Aging Population: An Investigation of the Interplay Between Depression Symptoms, Reward Processing, and Physical Activity in Older Adults

Jet Taylor (University of Idaho), C.J. Brush (Auburn University), Lynda Ransdell (Boise State University), & Mariane Bacelar (Boise State University)

PURPOSE: To better understand the mechanisms underlying depression by investigating depression symptoms, Reward Positivity, and physical activity in older adults. **METHODS:** Thirty participants had their brain activity measured during a task used to elicit the Reward Positivity and

completed self-report measures of depression symptoms and reward valuation and satiation. Physical activity was monitored by accelerometry for one week. **RESULTS:** Contrary to predictions, Reward Positivity amplitude was not associated with depression scores, reward valuation, reward satiation, or physical activity. **CONCLUSION:** Despite null findings, the use of EEG and accelerometry remains informative and highlights the need for more studies on depression mechanisms in older adults.

"If It's 'Unnatural,' Why is it Normal?": Investigating the Role of Media and Sport in Normalizing Conformity to Orthodox Gender Roles

Shira J. Hirschel (California Polytechnic State University, San Luis Obispo)

PURPOSE: To better understand how sport as a cultural institution, together with media portrayals of gender, implicitly reinforces conformity to orthodox gender role ideology. **METHODS:** Through an undergraduate course project, one documentary and one qualitative research study were descriptively analyzed and compared. **RESULTS:** Common themes included idealization of hyper-masculine and hyper-feminine identities and expressions, the notion that there is only one correct way to perform gender, and the framing of orthodox gender roles as innate. The qualitative study illustrated coercive events such as bullying and hazing traditions that objectify women and femininity. **CONCLUSION:** The symmetry between media narratives and athlete socialization events suggests that media and sport together normalize exclusion and invisibility of people who do not conform to orthodox gender roles.