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Eric M. Martin

Boise State University

Larissa True

New Mexico State University

Karin A. Pfeiffer

Michigan State University

Shannon R. Siegel

University of San Francisco

Crystal F. Branta

Michigan State University

See next page for additional authors

Authors

Eric M. Martin, Larissa True, Karin A. Pfeiffer, Shannon R. Siegel, Crystal F. Branta, Dave Wisner, John Haubenstricker, and Vern Seefeldt

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Eric M. Martin
Boise State University

Karin A. Pfeiffer
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Crystal F. Branta
Michigan State University

John Haubenstricker
Michigan State University

Larissa True
New Mexico State University

Shannon R. Siegel
University of San Francisco

Dave Wisner
Central Michigan University

Vern Seefeldt
Michigan State University

Abstract

Research tracking sport participation from youth to adulthood is relatively rare, as is research that tracks youth sport participation with regard to adult physical activity (PA) levels, especially in the United States. Aims of this study were: 1) To investigate the degree to which sport participation tracked across youth, adolescence, and early adulthood in a sample of participants from the Michigan State University Motor Performance Study (MPS), and 2) Determine if differences existed in their levels of adult PA relative to prior sport participation. In total, 256 (60.8%) former participants from the MPS completed follow-up surveys regarding routine sport participation and PA across the previous year. Sport participation tracked consistently from youth to college. Further, regardless of the level of youth sport participation, adult leisure time PA was relatively consistent among groups. Although the study did not directly test the influence of the MPS on subsequent adult outcomes, our findings suggest that participants' past sport participation was not a good predictor of adult PA for those who were involved in a program that emphasized fundamental motor skills in youth. Further investigation of such programs can help to better inform their influence on adult PA.

Keywords: early childhood, motor learning, physical activity, sport

Introduction

It is well-known that routine physical activity (PA) has wide-ranging benefits including improving overall physical health outcomes (Reiner, Niermann, Jekauc, & Woll, 2013), and psychological and social well-being (Eime, Young, Harvey, Charity, & Payne, 2013). However, the most recent Physical Activity Guidelines for Americans indicated that only 26% of men, 19% of women, and 20% of adolescents report sufficient activity to meet guidelines related to aerobic and muscle-strength fitness (US Department of Health and Human Services, 2018). As movement habits formed in childhood at least partially influence adult behaviors (Stodden et al., 2008), it is likely that childhood and youth activities that emphasize movement and movement-related skills would influence movement engagement and overall levels of PA in adulthood. Therefore, individuals who have childhood experiences that focus on movement outside of routine daily activities should be of particular interest to researchers when considering influences on adult PA.

Related to the concept of youth movement relative to subsequent PA outcomes, Stodden and colleagues (2008) proposed a model that emphasizes the influence of PA and motor competence as an explanation for future engagement in PA. In the model, researchers hypothesized that reciprocal relationships among motor competence, PA, perceived motor competence, and health-related fitness exist in childhood and influence a child's risk for obesity. These relationships are "reciprocal" because a child's risk for obesity would influence their future PA, motor competence,

perceived competence, and fitness. Given the number of investigations that have examined the various pathways and hypotheses proposed in the model (see Robinson et al., 2015 for a review), it is assumable that PA and sport participation tracks throughout childhood into adulthood and these relationships would impact adult levels of PA.

One indicator of childhood sport experiences' impact on future movement activities is whether or not sport participation tracks throughout childhood and into adulthood. This relationship has been studied previously, but the majority of studies have included international samples (e.g., Belgium; Sweden). For example, Vanreusel and colleagues (1997) investigated a group of 236 male participants from Belgium who ranged in age from 13-35 and found that tracking of sport participation was moderate to high in youth, and low to moderate from youth to adulthood. Similarly, in a sample of Belgian women, Scheerder and colleagues (2006) found that tracking of sport participation from late adolescence to adulthood was moderate. A more recent study of individuals in the Leuven Longitudinal Study on Lifestyle, Fitness and Health (LLSLFH) by Borgers, Vanreusel, Lefevre and Scheerder (2018) indicated that prior sport history played an important role in explaining middle-aged adult sport participation, but these relationships tracked more consistently at later stages of life than from adolescence. Finally, in a retrospective recall study with Swedish university students, Söderström, Fahlén, Ferry and Yu (2018) found that adult sport participation was related to individual recall of high-level sport performance during adolescence. These studies indicate that sport participation in childhood and adolescence may help to predict sport participation as adults, but the studies were conducted on non-US populations and on samples without experience in programs that emphasized PA or movement in youth.

In addition to investigating the stability of sport participation throughout adolescence and early adulthood, investigating how these sport experiences influence adult levels of PA is also important to consider. Generally, we would expect that youth sport participation would positively predict adult PA and several studies have indicated this relationship. For example, Tammelin and colleagues (2003) surveyed nearly 8,000 Finns at age 14 and subsequently at age 31, and found a positive correlation between sport involvement during adolescence and adult PA. Similarly, Telama, Yang, Hirvensalo, and Raitakari (2006) found that for participants in the Cardiovascular Risk in Young Finns Study, participation in youth sport significantly predicted adult level of PA for both male and female participants. Finally, Kjønniksen, Anderssen, and Wold (2009) found that PA at age 23 was significantly predicted by the age at which participants entered into sport as well as the number of years they participated in sport. Collectively, these studies indicate that sport participation relates to adult levels of PA, but again, they primarily focus on non-US groups and samples without specific experiences in youth programs that emphasized PA or movement.

Unsurprisingly, Tammelin and colleagues (2003) also found that the PA domains in which adults participated were representative of sports they had played during adolescence. The connection between youth sport participation and adult PA seems intuitive, but the mechanisms behind the relationship between youth sport participation and adult PA still are not fully understood. One possible explanation for the relationship between youth sport participation and adult PA is that youth develop fundamental motor skills (FMS) through sport participation. FMS are the building blocks of more advanced, complex movements composed of locomotor skills (e.g., moving the body through space, including running, galloping, skipping, hopping, sliding, and leaping) and object control skills (e.g., manipulating and projecting objects including throwing, catching, bouncing, kicking, striking and rolling; Logan, Ross, Chee, Stodden, & Robinson, 2018; Seefeldt 1980). These FMS may provide a foundation for a more physically active lifestyle in adulthood. If this explanation is true, sport participation is solely an indication that FMS development has occurred. Conceptually, if youth have other avenues to develop FMS outside of sport, or in conjunction with sport, this relationship between sport participation and adult PA might be less important.

In theory, if a program taught children FMS at young ages, those children could have the requisite skills necessary to be active adults. However, testing this proposition is difficult. Specifically, programs that emphasize FMS development and not just sport-specific skills are relatively rare, and if these programs exist, following participants for several years after their involvement in the program is logistically challenging. One such program that fulfills both of these aspects is the Michigan State University Motor Performance Study (MPS) which started in 1967 with the goal of teaching FMS to youth while tracking growth and development over time. The MPS provided instruction on motor skill development to children and adolescents aged 4.5-13.0 years of age daily during selected weeks of the summer and on Saturday mornings during the school year (retrieved from Haubenstricker & Feltz, 1999). The MPS' general focus on motor skill development, tracking participants across time (and after program conclusion), and the use of a generally healthy population all indicate important conclusions could be drawn from this participant group. As these

participants were enrolled in FMS training outside of the normal physical education courses, investigating their past and current movement behaviors might inform how programs that emphasize FMS could support more positive adult-level outcomes.

Therefore, the purpose of the present study is twofold. First, as sport participation may be an aspect that would influence adult PA, we aimed to investigate the degree to which sport participation tracks during youth, high school, and college adulthood in this group of participants. As previous studies have shown that sport tracks at a moderate to high level (Borgers et al., 2018; Scheerder et al., 2006; Söderström et al., 2018; Vanreusel et al., 1997), we hypothesized that individuals would be relatively consistent in their level of sport participation throughout the three time points, but these relationships would be stronger the closer in time they were measured. Second, as all of these participants were in a program emphasizing FMS development, we aimed to investigate if differences existed in levels of adult PA between participants relative to their past sport participation (during adolescence, high school, and college). Previous studies have shown that youth sport participation is positively related to adult PA (Kjønniksen, Anderssen, & Wold, 2009; Tammelin et al., 2003; Telama et al., 2006), and thus, we expected individuals with higher sport participation in each age group to engage in more self-reported adult PA than their counterparts with less sport participation.

Methods

Data were collected from participants of the MPS. In total, the MPS had 1,216 participants totaling 14,877 observations over 26 years. Participants in the MPS were assessed biannually on various growth and health-related fitness variables. Participants attended regular schools in 20 districts near the university and were healthy, free of overt disease, and had no physical, mental, or emotional disabilities. Following completion of the MPS, researchers initiated a follow-up study with the intent of investigating program participants' adult PA, sport participation, and health outcomes.

Participants were eligible to participate in the follow-up study if they had participated in a minimum of eight data collection sessions throughout the duration of the MPS. Of the total MPS population, 421 were eligible for participation in the study. Surveys were mailed to all eligible participants, and 256 (60.8%) were fully completed and returned. This mixed-longitudinal sample of participants were, on average, 33.85 years of age (range 22-43) and participated in an average of 23 observations (range 8-41), indicating that participants entered into the program at various time points and that they were highly active in the program (observations occurred 6 months apart).

Leisure time PA (LTPA) was assessed by the Minnesota Leisure Time Physical Activity questionnaire (Taylor et al., 1978). The questionnaire lists 90 individual physical activities that fit in one of six major domains of PA (i.e., sports, conditioning exercises, fishing and hunting, home repair, lawn and garden, walking, and miscellaneous). Participants indicated the number of occasions per month during the previous 12 months that they performed each activity and its average duration in minutes. Activities are classified as either light, moderate, or heavy in intensity. Light activities are those requiring approximately 8.4 to 16.8 kJ/min (2 to 4 kcal/min; walking for pleasure, bowling, and raking leaves); moderate, 18.9 to 23.0 kJ/min (4.5 to 5.5 kcal/min; baseball/softball, golf without a cart, and dancing); and heavy, 25.2 kJ/min (6.0 kcal/min or more; soccer, running, and hiking). In this study, results are reported based on LTPA in mean minutes per day for the year preceding the completion of the questionnaire. Scores for each participant were calculated for light LTPA, moderate LTPA, heavy LTPA, and total LTPA.

Participants answered questions about their youth sport participation in 35 different sports. These sports included traditional sports such as baseball, soccer, and track and field, as well as non-traditional activities like Karate, Judo, and downhill skiing. To assess participation in youth, participants were classified as either participants or non-participants for their engagement in recreational sports (e.g., organized sports such as community recreational leagues, summer softball, AAU basketball, etc.). For high school participation, participants answered questions regarding their engagement in interscholastic sports. Interscholastic sports included any high school sports activity in which organized practices and scheduled contests between schools were a part of the activity. Participants were classified as either non-participant, single sport, or multiple sport. Finally, participants' levels of participation in college were classified at three levels: intercollegiate varsity (e.g., sports at the college level in with scheduled contests between other institutions), college intramurals (sports at the college level in which contests between teams from the same institution provide the competition), or no participation.

A variety of analyses were conducted to answer the study's research questions. Descriptive statistics (age, BMI) and average daily energy expenditure were calculated and reported as means (\pm SD). Percentages of self-reported health, activity level, and physical fitness were reported for the total sample and by gender (see Table 1). To investigate the stability of sport participation, three chi-square tests were conducted. The first investigated youth recreational sport participation and high school participation, the second examined youth recreational sport participation and college sport participation, and the third examined high school sport participation and college sport participation. To investigate the differences in these groups and their adult PA, a series of MANCOVAs were conducted. For each MANCOVA the independent variable was participation level (rec sports: yes, no; high school: none, single sport, multi-sport; college: none, intramural, varsity), dependent variables were LTPA (total, light, moderate, heavy), and both age and gender were used as covariates. Age and gender were included as covariates in the MANCOVAs because participants had a wide range of ages at which they completed the follow up survey, and previous studies have shown there might be gender differences in assessing levels of PA (US Department of Health and Human Services, 2018). If the MANCOVA was significant, follow-up univariate ANOVAs were conducted with Tukey post hoc tests.

Results

Per the suggestion of Leon, Connett, Jacobs, and Rauramaa (1987), participants who indicated that their daily physical activity was greater than 360 minutes/day were excluded from all analyses. After elimination of nine individuals, 247 participants were included in the final analyses. Participants in the study were nearly evenly split between male ($n = 118$) and female ($n = 129$) respondents, were on average in their 30s ($M = 32.81$ years; $SD = 3.60$; range 21-42 years), and rated themselves on the whole as being very healthy, active, and physically fit (see Table 1 for complete demographic information).

The chi-square test analyzing the recreational sport groups with high school sport participation was significant, $X^2 (2, n = 247) = 7.78, p < .05$ (see Table 2). Specifically, participants who did not participate in recreational sports were significantly less represented in the multiple sport group than what would be expected. Further, participants in the no recreational sports group were more frequently represented in the no high school sport group, and the yes recreational sports group had higher representation in the multiple sport group in high school, but neither of these trends reached statistical significance.

The chi-square test analyzing the recreational sport groups with college sport participation was significant, $X^2 (2, n = 247) = 15.1, p < .001$ (see Table 2). Specifically, participants who did not participate in recreational sports were represented significantly more in the no sport participation and significantly less in the college intramural group than the group who participated in recreational sports.

A third chi-square test analyzing the high school groups with college sport participation was significant, $X^2 (2, n = 247) = 34.23, p < .001$ (see Table 2). Participants in the no high school sport group were represented significantly more in the no college participation group and significantly less in the college intramural group. Additionally, participants who played multiple sports in high school were represented significantly less in the no college sport participation group and significantly more in the college intramural group. Further, a larger number of multi-sport athletes and a smaller number of the no high school participation group were represented in the college Varsity group, but neither of these trends reached statistical significance.

A MANCOVA investigating differences in youth recreational sport groups (no recreational sports, yes recreational sports) on adult physical activity participation rates (total, light, moderate, heavy) with age and gender as covariates was non-significant, $F (6, 480) = .27, p > .05, \eta^2 = .00$. Age ($F (3, 241) = .24, p > .05, \eta^2 = .00$) and gender ($F (3, 241) = .33, p > .05, \eta^2 = .00$) were both non-significant. Similarly, a MANCOVA investigating differences in high school sport participation groups (none, single sport, multi-sport) on adult physical activity participation rates (total, light, moderate, heavy) with age and gender as a covariate was non-significant, $F (3, 240) = .77, p > .05, \eta^2 = .01$. Age ($F (3, 240) = .25, p > .05, \eta^2 = .00$) and gender ($F (3, 240) = .35, p > .05, \eta^2 = .00$) were also non-significant.

A MANCOVA investigating differences in college sport participation groups (none, IM, Varsity) on adult physical activity participation rates (total, light, moderate, heavy) with age and gender as covariates was significant, $F (6, 482) = 2.24, p < .05, \eta^2 = .03$. Age ($F (3, 240) = .12, p > .05, \eta^2 = .00$) and gender ($F (3, 240) = .21, p > .05, \eta^2 = .00$) were not significant. Investigation of the univariate ANOVA follow up tests indicated that there were no differences in daily total, light, and moderate physical activity participation rates. There was a significant difference in heavy LTPA daily

score ($F(2, 242) = 4.29, p < .05, \eta^2 = .03$). Examination of Tukey post hoc tests indicated those individuals who participated in varsity sport in college had higher levels of heavy daily LTPA scores than those who only participated in intramurals or had no sport participation in college.

Discussion

The first aim of the study was to examine the degree to which sport participation tracked from youth to high school to college. Our results indicate that participation in sport from during these times seemed to track relatively consistently. Youth who did not participate in recreational sports during childhood were less likely than expected to be multi-sport athletes in high school, and more likely to have little sport participation in college. These results mirror several findings from past literature. Specifically, sport participation in our sample tracked at a similar level compared to groups in Belgium (Borgers, et al., 2018; Scheerder et al., 2006; Vanreusel et al., 1997) and Sweden (Söderströma et al., 2018). Similarly, our findings indicate that sport participation from high school to college tracked the strongest. This too mirrors similar findings that tracking was higher when the time elapsed was relatively short (Vanreusel et al., 1997). Surprisingly, sport participation from youth to college tracked at a higher level than sport participation from youth to high school even though the time frame was longer. Although youth who reported low levels of recreational sport were less likely to play sport later in life, it did not fully exclude them from all future sport participation. No one single pathway to high school and college sport participation existed for this group of participants. Interestingly, elite-level sport also mirrors the idea that there is no one single pathway to later sport participation. Martin, Ewing and Oregon (2017) found that Division I collegiate athletes varied significantly in their youth and adolescent sport experiences indicating no single pathway existed to elite-level sport participation either. Further research is needed to explore what might lead to sport participation later in life, with specific attention given to the various pathways that may exist. Thus, this exploration is especially important as recreational sports are becoming more expensive and exclusive due to cost (Coakley, 2017).

The second aim of the study was to determine if differences in adult physical activity existed relative to prior sport participation. The examination of various levels of sport participation in childhood, adolescence, and young adulthood indicated almost no significant differences in adult PA level. That sport participation was mostly unrelated to adult PA is surprising as previous studies have indicated that sport participation in childhood is related to adult PA (Kjønniksen et al., 2009; Tammelin et al., 2003; Telama et al., 2006). One explanation could be that our participants attended a program that emphasized FMS as children, where previous studies were conducted with participants who had no formal training in FMS. It might be that if youth engage in FMS programming during youth, formal sport may not be necessary to develop the requisite skills to be physically active later in life. In support of this idea, several studies have indicated the link between FMS in youth and PA. For example, object control skills at age 10 were positively associated with self-reported participation in moderate-to-vigorous PA six years later (Barnett et al., 2011), baseline FMS at age 12 predicted light, moderate, and vigorous PA at age 18 (Jaakola et al., 2016), and FMS at 6 years of age were positively associated with females' self-reported leisure-time PA at age 26 (Lloyd, Sanders, Bremer, & Tremblay, 2014). Previous interventions have shown success in developing FMS in as little as 6 weeks (Martin, Rudisill, & Hastie, 2009), and a meta-analysis by Logan and colleagues (Logan et al., 2012) indicated that interventions were successful at improving both object control and locomotor skills. Interestingly, in the Logan et al. meta-analysis (2012), the longest program length included was 35 weeks, which would pale in comparison to the duration of the MPS which ran over 30 years.

The unique nature of the MPS may be one reason why no differences existed in this group's adult levels of PA relative to their prior sport participation. In the program, youth attended weekly sessions designed by experts in the field, administered by qualified pre-physical education teachers, and participated in the program for multiple years. Although the MPS scope may be unrealistic for most programs, the level of interaction with qualified instructors with high-quality curriculum could be considered best practice. It is also critical to note that participants in our sample did not have their FMS measured to fully support this hypothesized link. Instead, we are assuming that youth who attended the program benefitted from the unique structure of the MPS and developed FMS as the program anticipated. This is an obvious limitation to our findings (see limitations section for a more in-depth discussion).

Finally, the only significant difference that existed in any of the groups in terms of adult PA was college varsity athletes' participation in high-intensity PA compared to those who played intramurals or were not active in college sport. This difference may indicate that individuals not only seek similar sport domains (Tammelin et al., 2003), but also intensity levels as well. As collegiate athletes transition out of sport, it may be beneficial to have them find a similar high-intensity outlet for physical activity. Additionally, these differences might indicate that encouraging non-

athletes to participate in such high levels of PA as their primary means of PA may not be beneficial or necessary, especially if they have never been introduced to activities such as these. Even though college varsity athletes had higher levels of high-intensity PA, in terms of total PA, there were no differences in any of the three groups. Encouraging non-athletes or less-skilled athletes to find alternative forms of PA instead of high intensity activities may be more realistic and better received.

Limitations

While our study adds to the current literature, we acknowledge several limitations that require explanation. Primarily among those concerns is the lack of an explicit measurement of FMS for our participants. Participants in the study participated in the MPS, which was an instructional program with the primary goal of teaching and enhancing sport skills in youth (Haubenstricker & Feltz, 1999). The program was overseen by a director with extensive expertise in developmentally-appropriate FMS instruction and the program was taught by undergraduate and graduate students with training in motor development. However, because we have no direct measure of the program's effectiveness, we can only assume that children and adolescents in the program were exposed to high-quality programming and thus benefitted from that instruction. Care should be taken when interpreting these results. Further, without a true control group from a similar environment, no clear cause and effect of the program can be assumed and all conclusions should be interpreted with caution.

Secondly, the measures used to assess sport participation might be a limitation. Participants self-reported their sport participation as either a participant or non-participant in a variety of sports. This measure does not indicate the quality of programming, but rather measures whether or not participants participated in programming. For example, an individual who played recreation basketball for one season would be classified similarly as someone who played recreational basketball for many seasons. This measure provides support for sport participation as a whole, but does not indicate the quality of sport participation.

The third limitation is related to our sample. Even though the MPS was designed to recruit youth from a wide range of backgrounds, there is no guarantee that this was achieved. For example, even though the call for participants was made through various forms of media (e.g., newspaper), some potential participants may not have seen the opportunity and consequently, were excluded from participation. Further, the study included only those who were healthy, high functioning, and active, which limits drawing conclusions to groups with physical limitations. Additionally, even though the response rate of 61% could be considered high for a longitudinal sample, this rate still leaves 39% of possible respondents unaccounted for in the project. There is no indication these individuals varied from those surveyed, but care should be taken in interpretation. Finally, although the longitudinal nature of the project and the larger set of participants is encouraging, the sample size of 256 is still relatively small to draw any large-scale conclusions. Therefore, due to the limitations, these factors should be considered when discussing the generalizability of the findings.

Conclusions

The current study adds to the literature on sport participation tracking and how past movement experiences influence adult PA, despite its limitations. Participants who were involved in the MPS reported high levels of health, PA, and physical fitness. Surprisingly, participants' adult PA did not seem to be dictated by past sport participation. The absence of a control group and direct assessment of FMS in youth is a specific limitation, but these results may indicate that if FMS are taught in youth, they can influence adult PA outside the influence of sport participation. For educators and those who work closely with children, the results speak to the importance of emphasizing FMS development in activities that are not necessarily centered on recreational or competitive youth sport settings. Additionally, as the program emphasized movement outside of regular physical education classes, this speaks to the idea that supplemental movement activities can aid in developing competencies that might influence subsequent PA. This concept might be especially important for those who might not have the means to participate in youth sport, which is becoming more expensive and exclusionary to those without the means to play (Coakley, 2017).

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Table 1. Descriptive statistics for total sample, male and female participants.

Variables	<u>Total</u> (n = 247)	<u>Men</u> (n = 118)	<u>Women</u> (n = 127)
Age, years (SD)	32.8 (3.60)	33.0 (3.29)	32.63 (3.86)
BMI, kg/m ² (SD)	24.00 (3.79)	24.34 (4.14)	23.70 (3.43)
Marriage Status			
% single	33.6	31.4	35.7
% married	59.9	62.7	57.4
% divorced	5.3	5.9	4.7
Self-reported Health			
% Excellent Health	54.3	58.5	50.4
% Good Health	41.7	37.3	45.7
% Fair Health	2.8	3.4	2.3
Self-reported Activity Level			
% Very Active	17.8	18.6	17.1
% Fairly Active	38.5	39.0	38.0
% Average Active	32.4	28.0	36.4
% Fairly Inactive	10.5	13.6	7.8
% Very inactive	0.4	0.8	0
Self-reported Physical Fitness			
% Above Average PF	37.2	39.8	34.9
% Average PF	53.8	50.8	56.6
% Below Average PF	8.5	9.3	7.8
Energy Expenditure, Daily METS			
Total EE (SD)	508.87 (389.88)	506.36 (393.06)	511.16 (388.46)
Light EE	74.12 (85.11)	77.33 (97.00)	71.20 (72.81)
Moderate EE	122.09 (140.40)	126.70 (130.10)	117.87 (149.58)
Heavy EE	312.66 (287.53)	302.33 (290.14)	322.11 (285.91)

Note: Participants left some demographic information blank so not all columns will add to 100%.

SD = standard deviation

Table 2. Maintenance of PA participation groups from rec sports to high school and college.

	Youth – High School				High School – College Participation				Youth – College Participation		
	None	Single Sport	Multiple Sport		None	College Intramural	College Varsity		None	College Intramural	College Varsity
No – Rec Sports	43.8% 32	26.0% 19	30.1% 22*	None	81.6% 71*	10.3% 9*	8.0% 7	No – Rec Sports	75.3% 55*	13.7% 10*	11.0% 8
Yes – Rec Sports	31.6% 55	19.0% 33	49.4% 86	Single	48.1% 25	32.7% 17	19.2% 10	Yes – Rec Sports	49.9% 85	33.3% 58	17.8% 31
				Multi-Sport	40.7% 44*	38.9% 42*	20.4% 22				
Chi Square Significance		7.78 .02				34.23 .001				15.1 .001	

*Represents classifications that were significantly different than what would be expected from a chi square test, $p < .05$.