Determinants of physical activity of transitioning adult children with Autism Spectrum Disorder

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HIGHLIGHTS

- Determinants of PA among ASD young adults vary according to level of ASD severity.
- Parent and adult child physical activity levels are highly related.
- Child age was strongest PA predictor among young adults with severe ASD symptoms.
- Significant PA predictors were detected across the SEM model.

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ABSTRACT

Many young adults on the autism spectrum do not attain the recommended minimum weekly amount of moderate to vigorous physical activity (MVPA) to prevent significant health risks. Autism symptoms as well as environmental factors may play a key role in the physical activity (PA) behaviors of young adults on the autism spectrum. The socioecological model (SEM) has been previously used to identify determinants of PA among people within many disability categories. Aims: Explore the overall relationship between determinants of PA of MVPA among parents and their young adult child with ASD as well as MVPA determinants segmented by caregiver level of support. Methods: 336 parents of adult children with ASD completed the Determinants of Physical Activity and Eating Behaviors for Young Adults with ASD Scale. Results: Children's weekly time spent in MVPA was predicted by parent self-reported MVPA, exercise competency, video game use, social skills, and neighborhood qualities. Parent weekly time spent in MVPA was predicted by their child's weekly MVPA, parent exercise competency, parent discretionary time, available home exercise equipment, and parent attitude towards physical activity. Conclusion: These results support the administration of quality community-based motor development, motor skills, and exercise skills programs focused on increasing physical activity and parent's influential role in their children's weekly MVPA.

1. Introduction

Autism Spectrum Disorder (ASD) is among the most commonly diagnosed disabilities in the United States. The United States Centers of Disease Control and Prevention (CDC) reports 1 in 54 children and adolescents are diagnosed with ASD (Maenner et al., 2020). Those on the spectrum share a common cluster of impairments including deficits in social and communication skills, repetitive behaviors and motor

What this paper adds

This is one of the first studies to evaluate the determinants of acquiring moderate to vigorous physical activity of both parents and their young adult children on the autism spectrum, segmented by caregiver levels of support.
development delays (American Psychological Association, 2013). In addition, many children and adolescents with ASD fall short of regularly attaining the recommended amount of physical activity (Bandini et al., 2013; MacDonald et al., 2011; Pan and Frey, 2005). Impairments in socialization, emotional regulation, motor abilities and fitness levels may be contributing factors to limited PA (Buchanan et al., 2017; Obrusnikova and Cavalier, 2011; Obrusnikova and Miccinello, 2012; Srinivasan et al., 2014). For example, deficits in coordination and motor skills in children with ASD have been observed and reported by parents, teachers, and researchers (Green et al., 2009; Provost et al., 2007; Staples and Reid, 2010). This lack of motor coordination can be frustrating for a child with ASD and may lead to an avoidance of PA (Pan, 2014). Also, situations and environments that demand social understanding (e.g., team sports and fitness classes) can challenge an adolescent with ASD and result in reduced participation (Pan et al., 2011). Keeping pace with the speed of a game and with how the players’ roles may change throughout the game (i.e., moving from offense to defense), or effectively interpreting and responding to multiple methods of communication used by teammates (e.g., hand movements, verbal cues, signs of disappointment, celebrations) can also be difficult for adolescents with ASD (Menear and Smith, 2011; Obrusnikova and Dillon, 2011; Obrusnikova and Cavalier, 2011; Orhrberg, 2013; Stanish et al., 2015). Finally, research shows that adolescents with ASD spend significantly more time in sedentary pursuits compared to peers without ASD (McCoy et al., 2016; Must et al., 2014). A major component of sedentary behavior is time spent watching television, movies, and playing video games, often referred to as ‘screen time’ (Chonchaiya et al., 2011; Mazurek and Wenstrup, 2013; Must et al., 2015).

An analysis of the 2016 National Survey of Children’s Health (Maternal and Child Health Bureau in Collaboration with the US Census Bureau, 2018) Survey revealed that low levels of PA coupled with sedentary behavior has led to consistent increased rates of overweight and obese adolescents with ASD compared to peers (Healy et al., 2018). Among youth with ASD, 19.4% were overweight and 23.05% were obese, while among typically developing youth, 14.9% were overweight and 15.91% were obese. Higher incidence of obesity was reported for youth with severe ASD compared to those with mild ASD (Healy et al., 2018). These statistics translate to higher rates of a host of associated health issues. A 2016 review of medical records from 48,762 children with ASD in the United States showed significantly higher rates of other obesity-related conditions, such as hypertension, high cholesterol and non-alcoholic fatty liver disease (Shedlock et al., 2016).

The combination of increased prevalence of obesity and availability and use of electronic media, and decreased levels of PA, is a major concern in adolescents with ASD (Must et al., 2015). Unfortunately, it is likely these negative behaviors in adolescents may worsen as ASD adolescents transition to adulthood. Upon graduation from high school, young adults with ASD no longer have access to organized public school physical education services, and many are underemployed or unemployed resulting in more discretionary time compared to young adults without ASD (Coleman and Adams, 2018; Roux et al., 2016). This extra leisure time is likely spent in sedentary (e.g., sitting) rather than active behaviors (e.g., jogging, weightlifting). This was confirmed in a longitudinal study in which PA and sedentary behaviors were tracked in individuals with ASD during childhood, early adolescence, and young adulthood (Eaves and Ho, 2008). Results indicated that less than half of the young adults in the sample engaged in moderate or vigorous PA at least once per week. In addition, these individuals spent 13 h per day sitting. Not surprisingly then, is a report showing that adults with ASD exhibit poorer overall health profiles and higher risk for chronic disease compared with adults without ASD (Tyler et al., 2011).

Failing to meet the minimum PA guidelines results in significant health risks. For example, regularly meeting the minimum weekly benchmark of 150 min of moderate-to-vigorous physical activity (MVPA) reduces health risks of acquiring cardiovascular disease, type 2 diabetes, metabolic syndrome, and several cancers (Physical Activity Guidelines Advisory Committee Scientific Report, 2018). Other benefits of meeting the PA guidelines include increases of life expectancy, quality of life, muscular and bone strength, mental health and mood, and capacity to complete activities of daily living (Warburton et al., 2020). Conversely, low levels of PA contribute to many major health risk factors including the development of metabolic syndrome, chronic health conditions, and obesity related comorbidities (Carson et al., 2016; Owen et al., 2010). In addition, physical inactivity is the fourth leading risk factor of overall mortality resulting in approximately three million annual deaths throughout the world (Cunningham et al., 2020). Sedentary behavior has been established as a significant risk factor for type 2 diabetes, cardiovascular disease, and increased preventable mortality (Patterson et al., 2018). Thus, establishing a weekly PA routine to meet the minimum PA recommendations (Bull et al., 2020; PAGAC, 2018) are needed to maintain health and function of young adults with ASD. Many factors are involved when assessing and modifying health behaviors (Sallis et al., 2006). A helpful theoretical frame used to identify factors associated with PA among young adults with ASD is the socioecological model (SEM).

1.1. Socioecological model

The SEM postulates that an individual’s health behavior is influenced by his or her proximal and more distant environments (McLeroy et al., 1988). The SEM provides a framework to identify the multiple factors that influence PA participation at the intrapersonal, interpersonal, organizational, community, and public policy levels (National Institutes of Health, 2020). Intrapersonal factors are the center of the model and include an individual’s functional and structural constraints such as knowledge, attitude, and impairment. Interpersonal factors are second-level factors, which refer to formal and informal social networks including relationships with significant others including family, family friends, and peers (King and Gonzalez, 2018). The third level focuses on how social institutions and organizations support or present barriers to PA. Examples include workplaces, schools, and professional and personal affiliations including adapted PA programs and Special Olympics. Community factors including the walkability of the residential neighborhood, public transportation, accessibility of parks and recreational centers encapsulates the fourth level in the SEM model. Public policy is the fifth and most distal level and includes local, state, and federal policies, regulations, and laws which facilitate or impede PA.

Physical activity behavioral change is a multifactorial national issue with multiple determinants located among each of the five levels of the SEM model (Sallis et al., 2006, 2015). The SEM model (see Figure 1) has been used to identify determinants of PA of people with mobility impairments (Vasudevan et al., 2015), university students with disabilities (Úbeda-Colomer et al., 2019), and children and adults with physical disabilities (Martin Ginis et al., 2016). Using the SEM model, two recent
qualitative studies shed light on barriers and facilitators of PA in young adults with ASD (Buchanan et al., 2017; Nichols et al., 2018). Investigators of both studies interviewed parents of young adults with ASD to better understand factors related to physical activity behavior among their young adult children. In both studies, common themes of both PA barriers and facilitators included parents, the environment and setting (access, opportunities, and safety), and behavioral symptoms associated with ASD. These two studies were limited to qualitative methods, small sample size, and were conducted with local samples of participants. In this study, we aimed to extend the previous PA determinants qualitative work by extracting and analyzing quantitative data and survey a larger, national sample of parents of young adults with ASD.

Health outcomes of young adults with ASD transitioning from secondary education to healthy and functional community living is an emerging national concern (USDHHS, 2017). In an effort to prioritize ASD research directions, Frazier et al. (2018) surveyed ASD stakeholders to identify and target ASD research priorities. Results indicated increasing health and well-being as well as transition to adulthood were two of the four identified ASD priorities. Howlin and Taylor (2015) and Warren et al. (2012) also noted the importance of identifying factors that influence health behaviors in adults with ASD to better inform intervention. Identifying factors associated with achieving the National Institutes of Health recommended minutes of MVPA for young adults with ASD who are transitioning to adulthood may partially meet the ASD research priorities and provide data to inform successful health interventions for transitioning young adults. Our purpose was to investigate determinants of PA among adolescents with mild to severe ASD symptomology located at the intrapersonal, interpersonal, organizational, community, and policy levels. The first objective of the present study was to identify the PA determinants of young adults with ASD. We hypothesized that individual (e.g., intrapersonal) and family factors (e.g., interpersonal) would yield the most influential PA determinants. As the SEM model predicts that interpersonal relationships influence behavior of adolescents with ASD, the second objective was to identify parent determinants of PA. We also hypothesized that individual and family factors would be most influential in predicting parent PA.

### 2. Methods

This study used a cross-sectional design using a Likert-type instrument.

#### 2.1. Participants

A total of 336 parents of young adult ASD children ages 18–28 were recruited through the Autism Speaks’ resource directory of programs national database of schools and facilities (Autism Speaks, 2020). These facilities were contacted via email to explain the purpose of the study and to share the survey. We also conducted an internet search of schools and programs serving children and adults with ASD across the U.S. to find additional contacts. We asked the director of each facility to send an email on their letterhead to parents of young adults with ASD asking them to participate in the study. A link to the survey was presented at the bottom of the email which when clicked, opened a web browser and directed participants to the study landing page. The landing page provided information about the study and included the consent form. Parents interested in participating were instructed to click on “agree” which lead them to the survey. A $100 donation or Visa gift card was offered to program directors to facilitate parent participation. In addition, each participant received a $20 Visa gift card as an incentive to complete the survey. Inclusion criteria included: a) parent or primary parent of a young adult with ASD between ages 18–28, b) child has been diagnosed ASD by a physician or school psychologist, c) child is not under exercise restrictions from a physician, and d) child lives at home under the parent’s care.

For two parent family households, the survey requested that the parent who provides the greatest amount of time providing support complete the survey. If the participating parent had more than one child with ASD, the parent was asked to refer only to their child which required the most amount of support. Only 50 surveys were completed after one month of recruitment. To increase enrollment, we identified and advertised the study on Facebook and other autism-specific social media platforms. In addition, we also increased participant compensation from $20 to $40. This resulted in 488 parents of adult children with ASD taking the survey. Of the 488 surveys, 152 were removed due to incomplete survey data, unreliable data entry (completing the survey in less than 3 min) or those who did not meet the study criteria including those too young or too old or who did not report physician ASD diagnosis. The final sample size was 336. See Tables 1 and 2 for participant demographics. Community members were not directly involved in this study, but parents who had a young adult child provided feedback on our created survey. A University Institutional Review Board for Human Subjects approved the study.

#### 2.2. Instrument

The Determinants of Physical Activity and Eating Behaviors for Young Adults with ASD (DPAASD) scale was used to collect data. This survey was hosted online via Qualtrics and contained five sections of related questions including, (a) parent PA behaviors, (b) child PA behaviors, (c) parent eating behavior, (d) child eating behavior, and (e) demographic information. Only the demographics, parent PA behaviors, and child PA behaviors sections were analyzed in this study. The DPAASD instrument contained a series of questionnaires to assess PA behavior of both parent and their adult child with ASD. The initial items were derived from previous PA determinants work (Nichols et al., 2018), the SEM, and the research team including researchers with prior experience in surveying and interviewing autistic people about their health behaviors. A draft of the survey was created by the authors and distributed to researchers investigating PA among people with ASD as well as parents with young adults with ASD. Based on feedback, the survey was revised, uploaded to the online survey platform Qualtrics, and then piloted with five parents who had children with ASD. Revisions were completed again resulting in the final survey which included 19 parent PA behavior items, 23 young adult child PA behavior items, 14 parent eating behavior items, 14 young adult child eating behavior items, and 22 demographic items, for a total

| Demographic Variable | Mild ASD | Moderate ASD | Severe ASD | Full Child sample |
|----------------------|----------|--------------|------------|------------------|
|                      | n        | %            | n          | %               | n    | %    |
| Sex                  |          |              |            |                 |      |      |
| Female               | 85       | 39           | 21         | 24              | 8    | 25   | 114  | 34   |
| Male                 | 131      | 61           | 67         | 76              | 24   | 75   | 222  | 66   |
| Employment Status    |          |              |            |                 |      |      |
| Not Employed         | 14       | 58           | 48         | 54              | 18   | 56   | 186  | 55   |
| Part Time Employed   | 71       | 33           | 28         | 32              | 5    | 16   | 104  | 31   |
| Fully Employed       | 21       | 10           | 12         | 14              | 9    | 28   | 42   | 13   |

Table 1. Child demographics.
of 92 items. Only the PA and demographic items, 64 items, were extracted and analyzed for this study. A power analysis indicated a minimum sample size of 205 for a multiple regression analysis with \( \alpha = .05 \), power \( (1 - \beta \text{ error probability}) = .95 \), 19 predictors out of a total of 92 was 225 for analysis of parent responses. A minimum sample size of 241 was recommended for 23 predictors out 92 total predictors was 241. G*Power version 3.1.9.7 was used to calculate minimum power to prevent committing a type-II error (Andrade, 2020). Cronbach’s alpha for the scale was \( \alpha = .78 \), meeting the recommended threshold for data reliability (Cronbach, 1951).

Participants selected from seven likert-scored answers from “Strongly disagree” to “Strongly agree”, to the items relating to the SEM model. Of items that needed a specific response, such as “On average, how many minutes per week do you exercise or are physical activity”, participants provided a precise answer (eg 150 min per week of exercise or physical activity). An informative definition of physical activity and exercise was provided for clarity. Examples of physical activities including brisk walking, aerobics, Yoga, jogging, bicycling, swimming, rowing, and shooting baskets were also provided. To avoid participant drift, items and their answer response options were strategically switched back and forth from a negatively worded item and/or answer option order to a positive worded item and/or option order (DeVellis and Thorpe, 2021). Example survey items of each SEM level include “My attitude towards physical activity prevents me from being active”, “My child/children help me be physically active”, “The neighborhood I live in prevents me from being physically active”, “Access to a fitness center (e.g., Gold’s Gym, Anytime Fitness) helps me be physically active”, “Transportation issues, such as not being able to drive to a local park or a fitness center, prevent me from being physically active.”

Participating parents were instructed to complete the PA section on parent behaviors, then were asked to complete the PA section concerning their child. Parents were instructed to consult and include their child's

### Table 2. Parent demographics.

| Demographic indicator | Mild ASD | Moderate ASD | Severe ASD | Full Parent Sample |
|-----------------------|----------|--------------|------------|--------------------|
|                       | n        | %            | n          | %                  |
| Sex (Female)          | 105      | 49           | 54         | 61                 | 19        | 59        | 336       | 100                 |
| Race                  | 164      | 76           | 64         | 72                 | 33        | 92        | 261       | 78                  |
| Black/African American| 10       | 4            | 8          | 9                  | 0         | -         | 18        | 5                   |
| Asian                 | 2        | 1            | 1          | 1                  | 1         | 2         | 4         | 1                   |
| American Indian/Alaska| 3        | 1            | 1          | 1                  | 1         | 2         | 5         | 1                   |
| Hispanic              | 27       | 12           | 8          | 9                  | 0         | -         | 35        | 11                  |
| Other                 | 0        | -            | 1          | 1                  | 1         | 1         | 2         | 1                   |
| Highest Educational Level |        |              |            |                    |           |           |           |                     |
| High School/GED       | 17       | 8            | 4          | 5                  | 1         | 3         | 22        | 7                   |
| Some College          | 41       | 19           | 13         | 14                 | 7         | 22        | 61        | 18                  |
| Bachelors             | 121      | 56           | 56         | 64                 | 22        | 69        | 199       | 59                  |
| Masters               | 33       | 15           | 12         | 14                 | 2         | 6         | 47        | 14                  |
| Terminal              | 4        | 2            | 3          | 3                  | -         | -         | 7         | 2                   |
| Family Size           | 2        | 15           | 11         | 13                 | 7         | 22        | 33        | 10                  |
|                       | 3        | 39           | 18         | 21                 | 24        | 11        | 34        | 71                  |
|                       | 4        | 107          | 49         | 32                 | 36        | 9         | 28        | 148                 |
|                       | 5        | 39           | 18         | 20                 | 23        | 2         | 6         | 61                  |
|                       | 6        | 16           | 7          | 1                  | 1         | 2         | 6         | 19                  |
|                       | 7        | 2            | 1          | 1                  | 1         | 1         | 4         | 1                   |
| Disability Benefits   | Yes      | 114          | 52         | 44                 | 50        | 13        | 41        | 171                 |
|                       | No       | 102          | 48         | 44                 | 50        | 19        | 59        | 165                 |
| Relationship Status   | Single   | 11           | 5          | 9                  | 10        | 5         | 16        | 25                  |
|                       | Separated| 3            | 1          | 4                  | 5         | 2         | 6         | 9                   |
|                       | Divorced | 7            | 3          | 3                  | 3         | 1         | 3         | 11                  |
|                       | Married  | 193          | 89         | 68                 | 77        | 23        | 72        | 284                 |
|                       | Domestic Partner | 2 | 1 | 1 | 1 | 1 | 3 | 4 | 1 |
| Housing Status        | Rent     | 32           | 15         | 13                 | 15        | 7         | 22        | 52                  |
|                       | Own      | 184          | 85         | 75                 | 85        | 25        | 78        | 285                 |
| Yearly Income         | $<25k    | 2            | 1          | 2                  | 2         | 1         | 3         | 5                   |
|                       | $25k-$50k| 2            | 19         | 4                  | 4         | 4         | 13        | 27                  |
|                       | $50k-$100k| 35          | 16         | 19                 | 21        | 15        | 47        | 69                  |
|                       | $100k-$150k| 82      | 38         | 38                 | 43        | 5         | 16        | 125                 |
|                       | $150k-$200k| 63      | 30         | 22                 | 25        | 6         | 19        | 91                  |
|                       | $200k+    | 14           | 7          | 2                  | 2         | 1         | 3         | 17                  |
|                       |          |              |            |                    |           |           |           | 4                   |
information when completing items about their child. The instrument was designed to allow participants to pause the survey, if desired, and then return to complete it at a later time. Participants were instructed not to disclose identifying information. Participants were assigned a random participant identification number via Qualtrics. All data was stored in the password protected University research lab computer.

2.3. Data organization

The DSM-V classification of the three levels of autism caregiver Levels of Support (APA, 2013) was used as a grouping variable when analyzing data. We labeled those needing Level 1 support as mild ASD symptoms, Level 2 support as moderate ASD symptoms, and Level 3 as severe ASD symptoms. Overall SEM determinants of child MVPA and parent MVPA was analyzed first, followed by SEM determinants of MVPA of child with mild ASD, moderate ASD, and severe ASD. Next analyses of SEM determinants among their parents were completed next.

2.4. Data analysis

Data were extracted from the Qualtrics software and imported into SPSS Version 25 for data analysis. Descriptive statistics for all variables are presented in means and standard deviations. Correlation and multiple regression analyses were used to evaluate the relationship between SEM determinants and child's time spent in MVPA. Multiple linear regression analysis assumptions testing indicated the data fit within the recommended guidelines for regression analyses (Lomax and Hahs-Vaughn, 2012). The outcome variable was weekly minutes of MVPA for both young adults with ASD and their parent. Data was also split by ASD severity, with weekly minutes in MVPA as outcome variable, which was determined by parental selection of amount of levels of support descriptions provided in the American Psychological Association's Diagnostic and Statistics Manual of Mental Disorders (APA, 2013). Stepwise variable selection method was used to maximize the contribution of each independent variable. Alpha level was set to .05 a priori.

3. Results

The relationship between SEM determinants and child's time spent in MVPA was evaluated using correlation and multiple regression analyses. Tables 3, 4, 5 and 6 summarize the means and standard deviations of the survey's PA items. Table 7 provides overall descriptive statistics, correlation, and multivariate analysis results examining the relationship between SEM determinants and overall Child's MVPA. Table 1 summarizes means and standard deviations of minutes per week spent in MVPA for the young adult children and their parent. A 2 (Group) by 3 (ASD Level) one-way ANOVA revealed no significant between-groups differences in minutes spent in MVPA (see Table 8), F(2, 333) = 2.21, p = .12.

Table 3. Child and parent means and standard deviations of potential determinates of MVPA.

| Child MVPA Determinants | Mean | SD | Parent MVPA Determinants | Mean | SD |
|------------------------|------|----|--------------------------|------|----|
| Child MVPA             | 124.81 | 65.46 | Parent MVPA              | 150.40 | 71.276 |
| Parent MVPA            | 150.40 | 71.276 | Child MVPA               | 124.81 | 65.46 |
| Parent Exercise Competence | 4.76 | 1.08 | Exercise Knowledge       | 4.73 | 1.25 |
| Daily Routine          | 4.74 | 1.24 | Access to Fitness Centers | 4.72 | 1.24 |
| Parent Attitude        | 4.61 | 1.21 | Exercise Competency      | 4.7 | 1.26 |
| Exercise Competency    | 4.52 | 1.12 | Access to home Exercise Equipment | 4.59 | 1.31 |
| Access to Community Act | 4.51 | 1.19 | Access to Community Fitness Programs | 4.52 | 1.18 |
| Peer Support           | 4.28 | 1.22 | Access to Community Activity Programs | 4.33 | 1.36 |
| Home Exercise Equipment | 4.2 | 1.30 | Family Pets              | 3.64 | 1.56 |
| Discrepancy Time       | 4.16 | 1.55 | Child Help Being Active  | 3.62 | 1.42 |
| Family Income          | 3.99 | 1.34 | Discretionary Time       | 3.61 | 1.63 |
| Digital Technology     | 3.95 | 1.51 | Access to Transportation | 2.53 | 1.40 |
| Sibling Influence      | 3.85 | 1.11 | Attitude towards Exercise | 2.47 | 1.67 |
| Obsessive-Compulsive Behaviors | 3.8 | 1.53 | Safe Neighborhood         | 2.14 | 1.41 |
| Friends Influence      | 3.79 | 1.38 |                           |      |    |
| Family Pets            | 3.74 | 1.51 |                           |      |    |
| Social Skills          | 3.64 | 1.48 |                           |      |    |
| Video Games            | 3.55 | 1.50 |                           |      |    |
| Aggressive Behaviors   | 3.54 | 1.33 |                           |      |    |
| Exercise Knowledge     | 3.51 | 1.50 |                           |      |    |
| Home Stimulus          | 3.35 | 1.48 |                           |      |    |
| Lack of Fitness Equipment | 3.34 | 1.44 |                           |      |    |
| Access to Community Fitness Programs | 3.18 | 1.33 |                           |      |    |
| Access to Fitness Centers | 3.14 | 1.41 |                           |      |    |
| Attitude towards Exercise | 3.02 | 1.59 |                           |      |    |
| Hyperactivity          | 2.92 | 1.55 |                           |      |    |
| Safe Neighborhood      | 2.38 | 1.40 |                           |      |    |

- Moderate to Vigorous Physical Activity.
- Standard Deviation.
- Outcome Variable.
- Significant Determinant (p > .05) of Child MVPA.
- Significant Determinant (p > .05) to Parent MVPA of Child with ASD.
3.1. SEM determinants and overall child MVPA

Children’s weekly time spent in MVPA was predicted by parent-reported MVPA, Exercise Competency, Video Games Use, Social Skills, and Safe Neighborhood. The resulting multiple regression model produced $F(5, 330) = 41.12, p < .001, r^2 = .375$. Parent’s MVPA, Exercise Competency, Social Skills, and Safe Neighborhood scores had positive effects, while Video Games Use had negative effects. The multiple regression model was:

\[
\text{Child's Weekly MVPA Time} = 16.01 + .35(\text{Parent's MVPA}) + 11.20(\text{Exercise Competency}) - 6.39(\text{Video Games Use}) + 10.64(\text{Social Skills}) + 8.03(\text{Safe Neighborhood})
\]

3.2. SEM determinants and overall parent MVPA

Table 9 summarizes the descriptive statistics and regression analysis examining the relationship between SEM determinants of PA and Parent MVPA. Parents self-reported weekly time spent in MVPA was predicted by Child MVPA, Parent Exercise Competency, Discretionary Time, Home Exercise Equipment, and Parent Attitude. The resulting model was $F(5, 331) = 68.62, p < .001, r^2 = .502$. Each factor had positive effects on Parent MVPA. The resulting model was:

\[
\text{Parent Weekly MVPA Time} = -23.76 + .37(\text{Child MVPA}) + 11.62(\text{Parent Exercise Competency}) + 13.70(\text{Discretionary Time}) + 8.25(\text{Home Exercise Equipment}) + 5.73(\text{Parent Attitude})
\]

3.3. SEM determinants and MVPA of children with mild ASD

Table 10 summarizes descriptive statistics and regression analysis results of MVPA by child ASD severity level. Young adults with reported Mild ASD ($n = 216$) weekly MVPA predictors included Parent MVPA, Exercise Competency, Routine, Hyperactivity, and Home Exercise Equipment. The resulting multiple regression model produced $F(5, 210) = 34.84, p < .001, r^2 = .440$ Each factor had positive coefficients except for Hyperactivity. The multiple regression model for Mild ASD MVPA was:

\[
\text{Mild ASD MVPA} = -49.36 + .33(\text{Parent MVPA}) + 9.94(\text{Exercise Competency}) + 12.50(\text{Routine}) - 7.46(\text{Hyperactivity}) + 8.57(\text{Home Exercise Equipment})
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**Table 4. Means and standard deviations of child and parent MVPA of level 1 ASD severity child.**

| Variable                                      | Mean | SD  | Variable                                      | Mean | SD  |
|-----------------------------------------------|------|-----|-----------------------------------------------|------|-----|
| Child MVPA                                   | 127.44 | 64.50 | Parent MVPA                                  | 158  | 68.38 |
| Parent MVPA                                  | 158  | 68.38 | Child MVPA                                   | 127.44 | 64.50 |
| Parent Age                                   | 46.97 | 6.08  | Parent Age                                   | 46.97 | 6.08  |
| Child Age                                    | 21.54 | 2.42  | Child Age                                    | 21.54 | 2.42  |
| Daily Routine                                 | 4.99  | 1.14  | Exercise Knowledge                           | 4.98  | 1.10  |
| Parent Exercise Competency                    | 4.86  | 1.06  | Exercise Competency                          | 4.89  | 1.16  |
| Parent Attitude                               | 4.74  | 1.18  | Access to Fitness Center                     | 4.78  | 1.19  |
| Exercise Competency                          | 4.71  | 1.03  | Access to Fitness                            | 4.69  | 1.07  |
| Access to Adapted Fitness Programs            | 4.64  | 1.17  | Home Exercise Equipment                      | 4.67  | 1.25  |
| Discrepancy Time                              | 4.41  | 1.48  | Participation in Adapted Fitness Programs     | 4.38  | 1.35  |
| Access to Exercise Equipment                  | 4.27  | 1.4   | Family Pets                                  | 3.82  | 1.54  |
| Peer Support                                  | 4.22  | 1.30  | Discrepancy Time                             | 3.78  | 1.58  |
| Family Income                                 | 4.09  | 1.32  | Children Help Being Active                   | 3.76  | 1.33  |
| Friends Influence                             | 3.97  | 1.33  | Access to Transportation                     | 2.29  | 1.32  |
| Sibling Influence                             | 3.93  | 1.09  | Attitude towards Physical Activity           | 2.11  | 1.53  |
| Digital Technology                            | 3.9   | 1.51  | Safe Neighborhood                            | 1.93  | 1.24  |
| Family Pets                                   | 3.77  | 1.51  |                                               |      |     |
| Obsessive-Compulsive Behaviors                | 3.71  | 1.61  |                                               |      |     |
| Video Games                                   | 3.51  | 1.52  |                                               |      |     |
| Social Skills                                 | 3.33  | 1.45  |                                               |      |     |
| Lack of Fitness Equipment                     | 3.32  | 1.45  |                                               |      |     |
| Exercise Knowledge                            | 3.21  | 1.45  |                                               |      |     |
| Aggressive Behaviors                          | 3.21  | 1.31  |                                               |      |     |
| Home Stimulus                                 | 3.13  | 1.41  |                                               |      |     |
| Access to Community Fitness Programs          | 3.1   | 1.34  |                                               |      |     |
| Access to Fitness Centers                     | 2.96  | 1.42  |                                               |      |     |
| Attitude towards Exercise                     | 2.87  | 1.58  |                                               |      |     |
| Hyperactivity                                 | 2.84  | 1.52  |                                               |      |     |
| Safe Neighborhood                             | 2.08  | 1.20  |                                               |      |     |

* Standard Deviation.

1. Moderate to Vigorous Physical Activity.

2. Outcome Variable.

3. Significant Determinant to Child with Level 1 ASD.

4. Significant Determinant to Parent MVPA of Child with Level 1 ASD.
3.4. SEM determinants and MVPA of children with moderate ASD

Weekly MVPA of children with Moderate ASD (n = 88) predictors included Parent MVPA, Aggressive Behavior, Community Fitness Programs, Child’s Discretionary Time, and Digital Technology Use. Each variable contributed positively to the model except Aggressive Behavior and Digital Technology. The resulting model for Moderate ASD MVPA was $F (5, 82) = 15.38, p < .001, R^2 = .473$:

$$\text{MVPA of Moderate ASD} = 86.33 + .37(\text{Parent MVPA}) - 18.52(\text{Aggressive Behavior}) + 17.69(\text{Community Fitness Programs}) + 8.41(\text{Discretionary Time}) + 143.83$$

3.5. SEM determinants and MVPA of children with severe ASD

Children with Severe ASD (n = 32) weekly MVPA predictors included Child Age, APA Programs, Social Skills, Child Attitude, and Parent Age. APA Programs, Social Skills, Child Attitude, and Parent Age had positive coefficients while Child Age had negative coefficients. The multiple regression model for Severe ASD MVPA was $F (5, 26) = 18.42, p < .001, R^2 = .50$.

$$\text{MVPA of Severe ASD} = 192.45 - 12.87(\text{Child Age}) + 29.04(\text{APA Programs}) + 24.87(\text{Social Skills}) + 15.41(\text{Child Attitude}) + 2.93(\text{Parent Age})$$

3.6. SEM determinants and parent MVPA of children with mild ASD

Table 11 summarizes descriptive statistics and regression analysis results of parent MVPA by their child’s ASD severity level. Physical activity determinants of parents of children with mild ASD (n = 216) included Child MVPA, Parent Discretionary Time, Parent Exercise Competency, Parent Attitude towards PA, and Safe Neighborhood. The resulting model produced $F (5, 210) = 45.84, p < .001, R^2 = .510$. Each factor had positive effects on the model and the resulting model was:

$$\text{MVPA of Parents of Young Adults with Mild ASD} = -11.24 + .37(\text{Child MVPA}) + 14.39(\text{Parent Discretionary Time}) + 14.68(\text{Parent Exercise Competency}) + 9.37(\text{Parent Attitude toward PA}) + 8.05(\text{Safe Neighborhood})$$

3.7. SEM determinants of parents MVPA of children with moderate ASD

Physical Activity determinants of parents of children with moderate ASD (n = 88) included Child MVPA, Access to Fitness Centers, Home Exercise Equipment, Transportation, and Parent Discretionary Time. The resulting model produced $F (1, 82) = 18.42, p < .001, R^2 = .50$. Each factor had positive regression weights and the resulting regression model was:

$$\text{MVPA of Parents of Young Adults with Moderate ASD} = 143.83 + .37(\text{Child MVPA}) + 16.82(\text{Parent MVPA}) - 18.52(\text{Aggressive Behavior}) + 17.69(\text{Community Fitness Programs}) + 8.41(\text{Discretionary Time}) + 143.83$$
MVPA of Parents of Young Adults with Moderate ASD = -67.52 + .53(Child MVPA) + 20.00(Access to Fitness Centers) + 10.47(Home Exercise Equipment) + 9.89(Transportation) + 8.48(Parent Discretionary Time)

3.8. SEM determinants of parents MVPA of children with severe ASD

PA determinants of parents of children with severe ASD (n = 32) included Parents Discretionary Time, Home Exercise Equipment, and Children Help Being Active. The resulting model produced F (3,28) = 41.12, p < .001, R² = .38.

### Table 6. Means and standard deviations of child and adult MVPA of severe ASD severity child.

| Child MVPA Determinant | Mean | SD | Parent MVPA Determinant | Mean | SD |
|------------------------|------|----|-------------------------|------|----|
| Child MVPA b           | 102.25 | 78.01 | Parent MVPA             | 117.16 | 79.18 |
| Parent MVPA            | 117.16 | 79.18 | Child MVPA              | 102.25 | 78.01 |
| Parent Age c           | 48.94  | 5.75  | Parent Age              | 48.94  | 5.75  |
| Child Age †            | 21.84  | 2.59  | Exercise Competency     | 4.31  | 1.32  |
| Social Skills d        | 4.47   | 1.24  | Access to Fitness Centers | 4.09 | 1.59  |
| Exercise Knowledge     | 4.44   | 1.34  | Access to Home Exercise Equipment e | 4.06 | 1.44  |
| Aggressive Behaviors   | 4.41   | 1.24  | Exercise Knowledge      | 3.9   | 1.35  |
| Home Stimulus          | 4.25   | 1.24  | Access to Community Fitness Programs | 3.61 | 1.44  |
| Peer Support           | 4.16   | 1.25  | Participation in Community Adapted Fitness Programs | 3.56 | 1.25  |
| Parent Exercise Competency | 4.06 | 1.08  | Attitude towards Physical Activity | 3.2   | 1.61  |
| Parent Attitude        | 3.97   | 1.33  | Children Help Being Active e | 3.19 | 1.66  |
| Access to Community Adapted Fitness Programs d | 3.83 | 1.11  | Family Pets             | 2.9   | 1.61  |
| Routine                | 3.75   | 1.27  | Access to Transportation | 2.87 | 1.48  |
| Obsessive-Compulsive Behaviors | 3.75 | 1.41  | Discrepancy Time e | 2.56 | 1.65  |
| Exercise Competency    | 3.75   | 1.34  | Safe Neighborhood       | 2.38  | 1.85  |
| Access to Home Exercise Equipment | 3.57 | 1.29  |
| Access to Community Fitness Centers | 3.56 | 1.41  |
| Family Income          | 3.5    | 1.57  |
| Video Game Use         | 3.48   | 1.5    |
| Digital Technology     | 3.48   | 1.41  |
| Sibling Influence      | 3.48   | 1.34  |
| Discrepancy Time       | 3.25   | 1.63  |
| Access to Community Fitness Programs | 3.23 | 1.54  |
| No Access to Home Exercise Equipment | 3.09 | 1.38  |
| Attitude towards Physical Activity | 3.06 | 1.59  |
| Friends Influence      | 3     | 1.37  |
| Family Pets            | 3     | 1.48  |
| Hyperactivity          | 2.97   | 1.58  |
| Safe Neighborhood      | 2.88   | 1.76  |

* Standard Deviation.
† Moderate to Vigorous Physical Activity.
‡ Outcome Variable.
§ Significant Determinant of Child MVPA with Level 3 ASD.
¶ Significant Determinant to Parent MVPA of Child with Level 3 ASD.

### Table 7. Overall child MVPA summary statistics, correlations, and regression analysis results.

| Variable | Mean (SD) | Correlations with Child MVPA | Regression Weights |
|----------|-----------|-------------------------------|--------------------|
| Child MVPA | 124.81 (65.46) | ** | b | β |
| Parent MVPA | 150.40 (71.28) | .49 | .35 | .38 |
| Exercise Competency | 4.52 (1.11) | .23 | 11.13 | .19 |
| Video Games | 3.55 (1.51) | -.30 | -6.36 | -.15 |
| Social Skills | 3.64 (1.48) | .23 | 9.88 | .22 |
| Neighborhood | 2.38 (1.39) | .11 | 8.03 | .17 |

F(5, 330) = 41.12, p < .001, R² = .38.

### Table 8. Mean and Standard Deviation (SD) of Self-Reported Young Adults and Parent Minutes per Week spent in MVPA.

|   | Mild ASD | Moderate ASD | Severe ASD | Total |
|---|----------|--------------|------------|-------|
| Child MVPA | 127.44 (64.5) | 126.55 (62.0) | 102.25 (78.0) | 124.81 (65.5) |
| Parent MVPA | 158 (68.4) | 143.8 (72.0) | 117.16 (79.2) | 150.40 (71.3) |

### Table 9. Overall parent MVPA summary statistics, correlations, and regression analysis results.

| Variable | Mean (SD) | Correlations with Parent MVPA | Regression Weights |
|----------|-----------|-------------------------------|--------------------|
| Parent MVPA | 150.40 (71.28) | ** | b | β |
| Child MVPA | 124.81 (65.46) | .49 | .38 | .34 |
| Exercise Competency | 4.70 (1.23) | .36 | 11.62 | .21 |
| Discrepancy Time | 3.61 (1.62) | .48 | 13.70 | .31 |
| Home Exercise Equipment | 4.59 (1.31) | .37 | 8.25 | .15 |
| Attitude | 2.47 (1.67) | .28 | 5.73 | .13 |

F(5, 331) = 68.62, p < .001, R² = .50.
### Table 10. Child MVPA summary statistics, correlations, and regression analysis results by ASD level of support.

| Variable                   | Mean (SD)       | Correlations with Parent MVPA | Regression Weights |
|----------------------------|-----------------|-------------------------------|--------------------|
|                            |                 | b                             | β                  |
| Level 1 (n = 216)          |                 |                               |                    |
| Child MVPA                 | 127.44 (64.50)  |                               |                    |
| Parent MVPA                | 148.00 (68.38)  | .51                           | .33                |
| Exercise Competency        | 3.21 (1.45)     | .19                           | 9.94               |
| Routine                    | 4.99 (1.14)     | .39                           | 12.50              |
| Hyperactivity              | 2.84 (1.52)     | -.26                          | -7.46              |
| Home Exercise Equipment    | 4.27 (1.40)     | .44                           | 8.57               |
| F (5, 210) = 34.84, p < .001 | R² = .440      |                               |                    |
| Level 2 (n = 88)           |                 |                               |                    |
| Child MVPA                 | 126.55 (61.98)  |                               |                    |
| Parent MVPA                | 143.83 (71.97)  | .49                           | .37                |
| Aggression                 | 4.02 (1.13)     | -.33                          | -18.52             |
| Community Fitness Programs | 3.38 (1.22)     | .26                           | 17.69              |
| Child Discretionary Time   | 3.89 (1.53)     | .22                           | 8.41               |
| Digital Technology         | 4.22 (1.50)     | -.05                          | -6.73              |
| F (5, 82) = 15.38, p < .001 | R² = .473      |                               |                    |
| Level 3 (n = 32)           |                 |                               |                    |
| Child MVPA                 | 102.25 (78.01)  |                               |                    |
| Parent MVPA                | 150.40 (71.28)  | **                            |                    |
| Child’s Age                | 21.84 (2.59)    | -.55                          | -12.87             |
| APA Programs               | 3.83 (1.11)     | .38                           | 29.04              |
| Social Skills              | 4.47 (1.24)     | .50                           | 24.87              |
| Child Attitude             | 3.06 (1.56)     | .32                           | 15.41              |
| Parent Age                 | 48.94 (5.75)    | .25                           | 2.93               |
| F(3, 28) = 17.39, p < .001 | R² = .610       |                               |                    |

### Table 11. Parent MVPA summary statistics, correlations, and regression analysis results by ASD level of support.

| Variable                   | Mean (SD)       | Correlations with Child MVPA | Regression Weights |
|----------------------------|-----------------|-------------------------------|--------------------|
|                            |                 | b                             | β                  |
| Level 1 (n = 216)          |                 |                               |                    |
| Parent MVPA                | 150.40 (71.28)  |                               |                    |
| Child MVPA                 | 127.44 (64.50)  | .51                           | .37                |
| Parent Discretionary Time  | 3.78 (1.58)     | .50                           | 14.39              |
| Parent Exercise Competency | 3.21 (1.45)     | .48                           | 14.68              |
| Parent Attitude            | 4.99 (1.14)     | .24                           | -9.37              |
| Neighborhood               | 2.84 (1.52)     | -.06                          | -7.46              |
| F (5, 210) = 45.84, p < .001 | R² = .510      |                               |                    |
| Level 2 (n = 88)           |                 |                               |                    |
| Parent MVPA                | 143.83 (71.97)  | **                            |                    |
| Child MVPA                 | 143.83 (71.97)  | .49                           | .53                |
| Fitness Center Access      | 4.80 (1.16)     | .45                           | 20.00              |
| Home Exercise Equipment    | 4.56 (1.36)     | .33                           | 10.47              |
| Transportation             | 2.98 (1.45)     | -.18                          | -9.89              |
| Discretionary Time         | 3.57 (1.58)     | .32                           | 8.48               |
| F (5, 82) = 18.42, p < .001 | R² = .500      |                               |                    |
| Level 3 (n = 32)           |                 |                               |                    |
| Parent MVPA                | 117.16 (79.18)  | **                            |                    |
| Parent Discretionary Time  | 2.56 (1.65)     | .65                           | 26.67              |
| Home Exercise Equipment    | 4.06 (1.44)     | .47                           | 16.86              |
| Children Help being Active | 3.19 (1.66)     | .54                           | 13.30              |
| F(3, 28) = 17.39, p < .001 | R² = .613       |                               |                    |
4. Discussion

This study aimed to explore possible determinants of weekly minutes spent in MVPA among young adults with ASD and their primary care parent using an SEM lens. Overall contributing factors associated with young adult time in MVPA included parent MVPA, exercise competency, video games use, social skills, and features of their neighborhood. The results of our regression equation indicates that on average, young adults of our sample completed 16 min of weekly MVPA. For every minute of MVPA completed by their parent, the adult child's minutes increased by .35 of 1 min. For every unit increase of the 1–7 likert scale response of reported exercise competency, the young adult's MVPA increased by 11.2 min. For every unit response to video game use, MVPA decreased by 6.39 min. For every unit increase of reported social skills evaluation, MVPA increased by 10.64 min. Lastly, for each unit increase of safe neighborhood evaluation, MVPA increased by 8 min. Interpretation of the remaining regression equations can be completed in the same manner. Unique factors associated with adult children with mild ASD symptoms included a daily routine, hyperactivity, and access to home exercise equipment. Access to community fitness programs, child's discretionary time, and digital technology use were determinants of young adults with moderate ASD. Finally, unique variables related to MVPA of adult children with severe ASD included child's age, access to adapted physical activity programs, social skills, child's attitude towards PA, and their parent's age. Determinants of overall parent MVPA included child MVPA, parent exercise competency, amount of parent discretionary time, availability of home exercise equipment, and parent attitude towards PA. The only unique factor of parents with young adults with mild ASD was safe neighborhood. Parent factors of adult children with moderate ASD included access to fitness centers and transportation access, while the only unique determinant of parent MVPA of young adults with severe ASD was support at home from their other children to engage in physical activity. Overall, no significant differences in minutes in MVPA were observed by ASD severity level of both adult children with ASD or their parents. Given the characteristics of our results, the discussion will be organized around the intrapersonal, interpersonal, organizational, and community levels.

4.1 Intrapersonal factors

Intrapersonal factors were significant contributors to PA in the mild and moderate ASD groups. Exercise competency, daily routine, and hyperactivity were significant factors in the mild ASD group, while aggressive behavior and the amount of the young adult's discretionary time were significant in the moderate ASD group. This finding is consistent with Buchanan et al. (2017) who reported young adults' perceptions of competence was an intrapersonal factor affecting MVPA. Attitude towards PA was the only intrapersonal MVPA factor among the severe ASD group. The distinction of factors between the two groups is understandable. Young adults with mild ASD are more independent and require less support from family and friends (APA, 2013). Issues interfering with MVPA participation such as a lack of routine, hyperactivity, and not feeling knowledgeable about physical activity, appear to be similar to comparison adults (Trost et al., 2002). Aggressive behavior and lack of discretionary time are also consistent with characteristics of those with greater ASD symptomology. People with moderate ASD severity tend to be more aggressive and need more direction and support in directing their discretionary time than those with less severe ASD (Miranda et al., 2019). For example, a young adult with mild ASD may exhibit increased aggressive behavior if his needs are not being met through a predictable day-to-day regimen, resulting in a decrease in discretionary time.

Parent discretionary time was an inverse MVPA determinant among both parents of mild and moderate ASD, while parent exercise competency and attitude toward PA were significant factors of parents of young adults with mild ASD symptoms. The lack of perceived available discretionary time to exercise is often a primary reported cause of adult's reported sedentary behavior (Ebben and Brudzynski, 2008). Our results, among parents of young adults with mild and moderate ASD severity, reflect this finding. Parent exercise competency, as defined by parent ability to complete the exercises they prefer to do, as well as attitudes towards PA are consistent with previous exercise behavior research (CDC, 2022; Nichols et al., 2018). Further investigation is needed to determine if these factors are significantly larger among parents with children with ASD.

4.2 Interpersonal factors

Interpersonal factors included social influences such as family and friends which impact MVPA participation of young adults with ASD. Parent and child MVPA were the strongest correlated factors. This finding is similar to the Nichols et al. (2018) study in which most interviewed parents were physically active and had positive attitudes towards PA. Access to home exercise equipment was significant for adult children with mild ASD and digital technology was a negative MVPA factor among adults with moderate ASD. Examples of digital technology provided to participants included iPads, tablets, and cell phones. While these devices could have exercise enhancing apps, parents reported the devices hindered physical activity. These factors are consistent with previous exercise literature (Herazo-Beltran et al., 2017). Access to proximate exercise equipment of both parent and adult child increases the availability and opportunity of PA without the need of additional resources such as a vehicle and a driver for transportation to access preferred PA equipment located at a nearby fitness facility. Parent MVPA was not a significant factor of adult children with severe ASD. Instead, we found factors such as the adult child's age and parent's age were negatively associated with young adult MVPA, while social skills was a positive association. These findings are consistent with previous exercise literature regarding neurotypical adults in which PA generally decreases as adults age (Troiano et al., 2008). Some means of PA, such as playing on team sports, require high functioning collaboration between teammates and opponents. Young adults with significant ASD symptoms may not have the social abilities to successfully participate in group PA settings which may be a cause for the inverse association between young adult social skills level and MVPA.

In addition to access to home exercise equipment, child sibling support was a second interpersonal factor of parents of severe ASD. Siblings of children with ASD often provide valuable support caring for their brother or sister (Phelps et al., 2009). It is feasible that parents access to discretionary time is increased the more care giving support another child can provide. These parents, then, may choose to spend this time exercising to increase their health and for the cognitive and emotional relief provided from their caregiving role.

4.3 Organizational

Access to community fitness centers was a key factor of MVPA among adult children with moderate ASD as was adapted physical activity community programs among children with severe ASD. Community programs provide PA opportunities to young adults with ASD who otherwise may not be able to exercise due to environmental constraints such as parent's discretionary time. Community programming as a key MVPA factor among young adults with ASD is consistent with reports from both Buchanan et al. (2017) and Nichols et al. (2018). Buchanan et al. (2017) reported that access to programs offered at the local YMCA
was critical to a research participants PA levels. Nichols et al. (2018) reported that over half the study sample participated in year-round Special Olympics programs. Even though qualitative reports of the added value of the community programs for adolescents with ASD have been previously reported (Nichols et al., 2018), our findings are the first to provide quantitative evidence of the association between community fitness centers and MVPA of young adults with moderate and severe ASD.

Access to fitness centers was a key PA factor of parents with children with moderate ASD. Access to fitness centers may not have been a factor among parents with mild or severe ASD children because of the lack of perceived discretionary time which was the greatest and second greatest determinant among parents with severe and mild ASD respectively. Discretionary time was the lowest factor among parents of children with moderate ASD. In other words, parents of children with severe or mild ASD did not have time to take their child to community fitness centers.

4.4. Community

No community factors were associated with children's MVPA. However, neighborhood access was a MVPA factor among parents of children with mild ASD and transportation issues was a contributing factor among parents with children with moderate ASD. Among the factors affecting parent MVPA, no neighborhood and access to transportation had the lowest impact and statically were not as influential in weekly MVPA as child MVPA, parent discretionary time, and attitude towards exercise. Some participants in the Nichols et al. (2018) study reported living in rural areas which prevented access to PA beyond the home environment. Many parent participants in our study reported their neighborhood was not conducive to PA, but interestingly this was only among the parents with children with mild ASD. This could be that parents of higher functioning adult children had higher expectations and desires for their child to be active but did not feel comfortable with their child exercising (e.g., walking) in the neighborhood. In contrast, parents of children with moderate and severe ASD may not have viewed their neighborhood as a plausible place to exercise because their child needed direct support which the parent was unable to consistently provide.

4.5. Limitations

Study limitations include convenience sampling, not utilizing a random sample of parents with young adult children with ASD, self-reporting, and parent completing the questionnaire for their child with input from the child. Participants valuing PA may have self-selected into the study, while those who were not as physically active may have self-selected out of the study, resulting in likely participant study bias. Data was cross-sectional and relied on parent self-reported recall of PA behaviors and factors affecting their activity. Some participants were removed from the analysis due to incomplete or unreliable data entry. A potential confounding PA issue among people with ASD is a potentially limiting definition of PA. Physical activity for most neurotypical adults is in the form of exercise, which is a pre-planned and executed PA session. In contrast, those with ASD, especially with severe ASD, may complete daily, habitual PA when engaging in self-stimulatory behaviors such as rocking and pacing. These behaviors may often meet the qualifications of moderate PA if it results in increased heart rate due to repetitive skeletal muscle contraction. Parents and some health experts may fail to identify these behaviors as meeting the guidelines for MVPA and unintentionally underreport weekly time spent in MVPA. Even though time spent in MVP produces a dose-response to many health conditions and diseases (PAGAC, 2018), the effects of other ASD-specific behaviors such as poor nutritional habits (Sharp et al., 2018) may act as confounding factors making it difficult to assess whether the additional MVPA through self-stimulating behaviors resulted in a decreased health risk or not. Due to the wide variance of ASD symptoms, a study strength was grouping ASD participants by severity level according to parent reported level of support (APA, 2013). In addition, the study sample included a relatively large sample of parents with young adult children with ASD residing throughout the US.

5. Conclusion

Results of the study lend support to utilizing the SEM model to identify predictive PA factors of young adults with ASD and their primary parents. Our data indicate physical activity barriers and facilitators differ by levels of ASD symptomology. The strongest factor of young adult MVPA was parent MVPA. Exercise competency, or perceived ability to successfully complete preferred exercises, was the next strongest factor followed by video game use, social skills, and neighborhood. For young adults with severe ASD, the most predictive factors were the child's age, APA programs offered in the community, the child's level of social skills, attitude towards PA, and parent age. For parents, child MVPA, parent's exercise competency, amount of discretionary time, home exercise equipment, and attitude toward PA were predictive factors. For parents with children with severe ASD, help from siblings of their child with ASD was a significant MVPA predictor. Our data provides empirical support for community motor development and motor skills programs focusing on increasing physical activity as well as parent's influential role in their adult child's weekly MVPA.

Declarations

Author contribution statement

Jason C Bishop, PhD; Chad Nichols, PhD; Sibylle Kranz, PhD; Julia Lukacs, PhD; Martin E Block, PhD: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data will be made available on request.

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The authors declare no conflict of interest.

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