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ORIGINAL PAPER

Can Participation in a Community Organized Football Program Improve Social, Behavioural Functioning and Communication in Children with Autism Spectrum Disorder? A Pilot Study

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Abstract
This pilot research investigated the effects of a community-based organized football program on behavioral, social and communicative outcomes in children with Autism Spectrum Disorder. In a non-randomized design, 19 children completed the football program and were compared pre- and post-intervention with 21 children who received no comparable intervention (ages 5–12 years). Caregiver-report using the child behavior checklist indicated a significant decrease in total, internalizing, DSM-oriented anxiety and social problems for children who participated in the program, with no change in the comparison group. There were no group differences in socialization and communication scores on the Vineland Adaptive Behavior scale. Results provide preliminary evidence in support of the program, justifying the need for further, more rigorous trials in this area.

Keywords ASD · Organized physical activity · Football · Social functioning · Internalizing · Externalizing

Introduction

Autism Spectrum Disorder (ASD) is characterised by difficulties with social interactions and verbal/non-verbal communication (American Psychiatric Association 2013). These social features are often accompanied by co-morbidities such as fine-and-gross motor impairments (Liu and Breslin 2013) and higher levels of emotional and behavioral problems (Chandler et al. 2016; Simonoff et al. 2008). More specifically, individuals with ASD are at a greater risk of exhibiting externalizing disturbances such as disruptive behaviors (Tonge et al. 1999) and internalizing problems such as elevated levels of depression (Matson and Nebel-Schwalm 2007) and anxiety (Gillott et al. 2001; Van Steensel et al. 2011). Research has established an overlap between the neural regions of the brain implicated in areas such as emotional regulation, (which is linked internalizing and externalizing behaviors (Sivaratnam et al. 2015)) and social functioning, for example; evidence from lesion studies indicates damage to prefrontal regions e.g. orbitofrontal cortex can lead to behavioral, social and emotional regulation changes (Bramham et al. 2009). Motor functions, similarly rely strongly on frontal regions, suggesting these links may also extend to motor domains. Interconnections between motor impairments and emotional, behavioral (Papadopoulos et al. 2012) and social problems (MacDonald et al. 2013) have been suggested in individuals with ASD.

Given the relevance of motor domains to ASD, there has been a call for ASD treatment to address motor related domains (Fournier et al. 2010). Some evidence indicates community-based lifestyle interventions that require motor skills such as physical activity are feasible within primary health care settings (Kallings et al. 2008). Further, Kazdin (2019) emphasized the importance of considering more novel models of mental health treatment delivery, given the barriers domineering current models (e.g. clinic-based programs run by highly trained professionals). As such, the last decade has seen an increased interest in researching

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concerning physical activity-based programs that take place outside the clinic for children with ASD specifically (Rinehart et al. 2018). It has been suggested that the difficulties individuals with ASD experience in areas such as social, communication, anxiety, and behavioral problems could be 'attenuated' through programs such as physical exercise and relaxation (Hillier et al. 2011, p. 396). Systematic reviews on physical activity specifically have demonstrated well established benefits to social functioning (Healy et al. 2018) and reductions in externalizing domains such as aggression (Lang et al. 2010) in individuals with ASD. Regarding internalizing domains, Hillier et al. (2011) found short-term decreases in cortisol levels and self-reported anxiety following a low-level physical exercise and relaxation program in adolescents and young adults with ASD without significant behavioral or communication challenges.

The current research examines a subset of physical activity, group-based organized physical activity (OPA), referred to as physical activities involving structured and formal training sessions, that are supervised by a coach or adult (Okely 1999) and have been organized by a sporting club or recreational association (Australian Bureau of Statistics 2013) (see Howells et al. 2019a, b, p. 3291). It is thought that adequately structured group activities (for example, with clear rules, time frames, and adult support) may provide a social scaffold for children with ASD (Sorensen and Zarrett 2014). The most recent meta-analysis of research examining OPA provides evidence for this idea (Howells et al. 2019a). This review investigated social functioning in children with ASD and identified 11 papers for systematic review that have empirically evaluated group-based OPAs which took place within their communities (e.g. horse-riding, karate, team sports such as soccer and a multi-sport camp) (Howells et al. 2019a). Six papers were included in the meta-analysis examining the effect of OPA on social functioning, with results indicating a significant improvement. Four papers were included in the analysis of communication, which failed to generate effects. Interestingly, research examining a group Karate program have found significant decreases in communication deficits in children with ASD (Bahrami et al. 2016), contrasting pooled results in Howells et al. (2019a). Given the paucity of studies available for meta-analysis in that review, further research is needed into the impact of OPAs on communicative domains in children with ASD to further clarify potential effects. Research has also provided some support for OPAs in terms of a reduction in behavioral problems in children with ASD. Several studies evaluating group horse-riding for children with ASD have also noted reductions in externalizing behaviors such as irritability, hyperactivity (Gabriels et al. 2015) and aggression specifically (García-Gómez et al. 2014). However, García-Gómez et al. (2014) noted no changes in internalizing domains (such as anxiety, depression, and withdrawal).

Howells et al. (2019a) also highlighted the paucity of research into the impact of more naturalistic, team sporting programs such as soccer. Such programs have been said to enable 'prosocial behaviors' and interpersonal interactions (Cei et al. 2017) and may reduce anxiety in social situations (Dimech and Seiler 2011). Interviews with the parents of 30 children with ASD indicated positive changes in social and communicative domains, and reductions in dysfunctional behaviors such as aggression and escape following a soccer program (Cei et al. 2017). Likert-scale ratings from 14 parents of children with ASD (with ranging severities) also noted percentage improvements in interactions with siblings and mood following a community-based soccer program (Hayward et al. 2016). However, much of this research has been qualitative or descriptive in nature, and more rigorous research using standardised measures is needed to examine the efficacy of such programs (Rinehart et al. 2018).

The aim of this study was to investigate the benefits of one of the most popular junior ball sports programs for children aged 5–12 years in Australia, NAB AFL Auskick (referred to as Auskick from here-on). This program is based on Australian rules football and has been reported as Australia's most successful junior sporting program (Smith 2005). Australian Rules Football is typically played on a grassed oval with an ovoid-shaped ball (Australian Football League [AFL] 2019). The junior program teaches the basics skills of Australian rules football via structured activities. Unlike junior sports where there may be minimum attendance requirements, this OPA football program offers families a choice of how many sessions they would like to attend, with programs running for various lengths. This may be advantageous for children with ASD and their families as time constraints due to factors such as therapy sessions and decreased energy have been listed as barriers to physical activity participation (Obrusnikova and Cavalier 2011). A feasibility study in 13 children with ASD found several significant improvements in parent-reported aspects of motor functioning (soccer kicking and object control skills) allowing children to have a more typical community experience (May et al. 2017). One parent stated "I think the major, major one was it sort of brought some sort of normality. Like what all the other kids were doing…" (May et al. 2017, p. 136). While these findings are promising, the effect of this program on social, communicative and behavioral domains is currently unknown. Given the similarities between this football program and soccer, it may be that positive results demonstrated for soccer may also result from Australian Rules football programs however research is needed to evaluate this.

There is currently uncertainty around what is considered the 'optimum' dosage in terms of program length to achieve maximum benefits (Howells et al. 2019a). The varied number of sessions attended in this study allows us to examine the impact of shorter or longer Auskick programs on changes

in functioning. Auskick also offers two types of programs (*mainstream* or *disability-focused*). *Disability-focused* programs can be further broken down into two subtypes, the first involves group activities specifically for children with disability, and the second gives children with disabilities an opportunity to complete activities in a group which runs 'side by side' to a *mainstream* group (AFL Victoria 2016). As well as being attractive to children with disabilities, who can choose how they would like to participate, it also offers a naturalistic opportunity to address an important research question in the field with regards to the optimum dosage of sessions for children to show physical and psychological benefits.

Aims

The primary aim of this pilot study was to assess whether there was a difference in social, communicative and behavioral outcomes between a group of children with ASD who participated in Australian rules junior football programs (Auskick), and a group of children with ASD who were not engaged in the football program. Secondly, it aimed to assess the relationship between the number of sessions attended and any differences in *pre*-and-*post* scores, and any group differences between the type of program attended (*mainstream* or *disability-focused*) and *pre*-and-*post* scores in children who participated in the football program.

Method

Participants

A parent/caregiver of sixty-one children ($n = 58$ boys; $n = 3$ girls) with ASD were recruited for the current study ($n = 29$ in the intervention group; $n = 32$ in the comparison group). Participants were recruited in two waves across 2017 and 2018 via advertisement flyers distributed to private paediatric clinics, community institutions, early intervention services, special development and mainstream schools across the state of Victoria, Australia. Advertisements were placed in community newspapers and research institution webpages. The AFL used Auskick databases as an avenue of recruitment, with individual football clubs also distributing flyers within their communities.

Participants were required to have a pre-existing diagnosis of ASD under the DSM-5 guidelines (American Psychiatric Association 2013), or a diagnosis of Asperger's, Pervasive Developmental Disorder-Not Otherwise Specified, or Autistic Disorder under the DSM-IV guidelines (American Psychiatric Association 1994) to be included in this study. To obtain a formal diagnosis in Victoria, Australia, a child must satisfy DSM criteria and have undergone a formal assessment through a multidisciplinary team (e.g. psychologists and speech pathologists). Diagnoses must then be confirmed by either a paediatrician or child psychiatrist. Children were also required to be between primary school-ages (5–12 years) as this is the required age to partake in the Auskick program. Entry into the intervention group was dependent on voluntary enrollment in a child's local Auskick program. Each child must have attended a minimum of 5 sessions, or in the case of six-week programs, must have missed no more than two sessions. Comparison group participants must not have been enrolled in the football program, or have been engaging in more than 30 min a week of OPA for the duration of the study (30 min was set as a maximum as it was believed less than this would not produce effects, with a previous review setting 30 min as a minimum for OPA program lengths (Howells et al. 2019a, b)). They were, however, permitted to engage in their typical, everyday routines (e.g. attending therapy and routine educational programs).

Of the 61 participants initially recruited, 17 were unable to complete the testing process, either due to child non-compliance, an inability to complete tasks or family unavailability. Of the children who completed both *pre*-and-*post* sessions, two parents were unable to complete the measures of child behaviors. One child from the comparison group was also removed as they engaged in > 30 OPA during the study duration and another was removed from the intervention group as they only attended two Auskick sessions. The final sample consisted of *forty* children (37 males; 3 females) aged between 5 years, 0.2 months and 12 years, 3 months ($M = 8.31$; $SD = 2.01$; IQ range 50–134). Nineteen children were enrolled in the Auskick program and comprised the intervention group (17 males; 2 females), with 21 children in the comparison group (20 males; 1 female). This ratio of males to females is consistent with numbers participating in Auskick. Of the 19 in the intervention group, 11 were enrolled in a *mainstream* Auskick centre and eight in a *disability-focused* centre. It is important to note three participants of this 40 were unable to complete the measure pertaining to socialization and communication, hence the sample used in these analyses is 37.

Intervention: An Australian Rules Football NAB AFL Auskick Program

As this was a naturalistic, community-based study, each child within the intervention group voluntarily participated in the program at local Auskick clubs, located throughout Victoria, Australia. When enrolling in the program, families were linked to the AllPlay Footy website, a resource for children, parents, coaches and health professionals which provides information (e.g. information around the characteristics of various disability types) and strategies to facilitate inclusion into the football program (AllPlay Footy

2018). The types of coaching strategies includes information around how to modify the game to suit children with different needs (for example, the CHANGE IT approach, which is detailed more thoroughly in Howells et al. (2019b), provides a structure for changing aspects of the activity such as the environment, equipment used, rules of the game, timing of activities). Each Auskick session was run by volunteer coaches from within the community. The sessions were run in groups where children were given the opportunity to practice fundamental motor and football related skills(e.g. kicking, marking the ball [catching] and bouncing the ball) and participate in modified football games. Each session ran from 60 to 90 min in total, once a week. As mentioned, the length of each Auskick season varies depending on the club and as such, each child completed a varied number of sessions. The average number of sessions offered by the Auskick programs was 14 (*SD* = 4.30; *Range* 6–22 weeks). Children in the current study attended an average of 12 sessions (*SD* = 4.76; *Range* 4–21 weeks).

Measures

Demographic Information

Basic demographic information (refer to Table 1) were obtained through either a parent report survey designed for the purposes of this study or via screening questions upon entry into the study. Childrens' level of cognitive functioning was measured using a Full-Scale Intelligence Quotient (FSIQ) obtained from age-appropriate Wechsler tests of Intelligence (e.g. Wechsler 2011, 2012, 2014). The severity of ASD symptoms was measured through the total score of the Social Responsiveness Scale-Second Edition (SRS-2) school-age form. This is a 65-item, objective measure of ASD symptomology and the severity of social impairments (Constantino and Gruber 2012).

Behavioral and Emotional Functioning

Behavioral and emotional functioning was assessed using the Child Behaviour Checklist (CBCL)—caregiver version. This measure obtains caregiver or parent reports of children's competencies and problem behaviors. The CBCL has two separate forms spanning across two age bands, both of which were required for the current study; preschool-aged (1.5–5 years [100 items]) (Achenbach and Rescorla 2000) and school-aged (6–18 years [113 items]) (Achenbach and Rescorla 2001). It is a widely used caregiver report measure assessing problem behaviors in child cohorts, summing problems into three broadband scores; *Internalizing*, *Externalizing* problems and *Total* problems (Achenbach and Rescorla 2001, 2000). The total problems score comprises the internalizing and externalizing broadband scores as well as the separate subdomains *Social, Thought* and *Attention* problems (6–18 years), *Sleep* problems (1.5–5 years), and *Other* problems on both forms. Both forms also offer

Table 1 Child participant characteristics at baseline

Characteristic	Intervention group ($n = 19$)	Comparison group ($n = 21$)	Total ($n = 40$)	p value[b]
Age M(SD)	7.98 (1.71)	8.62 (2.26)	8.31 (2.01)	.32
Gender				
Male *n* (%)	17 (89.50)	20 (95.20)	37 (92.50)	.60
Female *n* (%)	2 (10.50)	1 (4.80)	3 (7.50)	
FSIQ ($n = 38$)[a], *M* (SD)	93.63 (19.17)	85.21 (20.66)	89.42 (20.12)	.20
ASD severity (SRS-2) ($n = 38$)[a], *M(SD)*	76.28 (8.39)	76.75 (10.09)	76.53 (9.20)	.88
Adaptive functioning (VABS-3) ($n = 39$)[a], *M(SD)*	75.67 (8.12)	71.95 (7.67)	73.67 (8.00)	.15
Parent reported co-morbidities				
Anxiety/depression *n* (%)	3 (15.80)	8 (38.10)	11 (27.50)	.16
ADHD *n* (%)	8 (42.10)	6 (28.60)	14 (35.00)	.51
Language/intellectual disability *n* (%)	2 (10.50)	8 (38.10)	10 (25.00)	.07
ODD *n* (%)	1 (5.30)	2 (9.50)	3 (7.50)	1.00
Vision/hearing impairment *n* (%)	4 (21.10)	3 (14.30)	7 (17.50)	.69
n days between baseline and post assessments *M(SD)*	178.26 (46.54)	175.05 (38.37)	176.57 (41.92)	.81
OPA during Auskick season *n (%)*	11 (57.90)	5 (23.80)	16 (40.00)	.05
Routine therapy during study *n (%)*	16 (84.20)	18 (85.70)	34 (85.00)	1.00

FSIQ Full Scale Intelligence Quotient, *SRS-2* Social Responsiveness Scale-Second Edition, *VABS-3* Vineland Adaptive Behaviour Scale-Third Edition, *ADHD* Attention Deficit Hyperactivity Disorder, *ODD* Oppositional Defiant Disorder

[a]Data only available for that number of participants

[b]Two-tailed *p*-value from independent samples t-tests or Fisher's exact test for categorical data

DSM-oriented Scales to provide a closer linkage to DSM diagnoses (Achenbach et al. 2003). These scales consist of depressive, anxiety, ADHD and ODD problems. The school-aged form also offers a DSM-oriented somatic and conduct problems score, and the preschool-aged offers ASD related problems. Both 1.5–5 and 6–18 years forms have demonstrated acceptable psychometric properties (Achenbach and Rescorla 2001; Ivanova et al. 2010). As the individual subdomains reported in the pre-school and school-aged forms differ, no analyses were conducted on the subdomains which make up *Internalizing, Externalizing* or the *Total* problems score, except for the *Social Problems* score included on the 6–18-year-old form. Broadband scores that reached significance were investigated further using relevant DSM-oriented problem scales that were consistent across both age-bands. *T* scores were used for the purposes of this study. For internalizing, externalizing and total problems, a *T* score of above 63 falls within the *clinical* range, scores of 60–63 fall within the *borderline clinical* range, and scores below this fall within the *normal* range. For all other subscale and DSM-oriented scales, scores of < 65 fall within the *normal* range, scores of 65–69 fall in the *borderline clinical* range and scores of ≥ 70 fall within the *clinical* range.

Social Functioning and Communication

Social functioning and communication were assessed through the Vineland Adaptive Behavior Scale-third edition (VABS-3) domain-level parent/caregiver report form. This is a widely used 180-item measure of adaptive functioning and can be administered from birth to up to 90 years-of-age (Sparrow et al. 2016). It comprises of four subscales; communication, daily living, socialization, and motor skills (Sparrow et al. 2016). For the purposes of this paper only the *Socialization* (which assesses interpersonal relationships, play, and leisure activities, and coping skills in social situations) and *Communication* (which assesses taking in information, verbally expressing self and reading/writing) subscale standard scores will be referred to. Both the communication and socialization domains have demonstrated excellent internal consistency, and adequate test–retest validity (Sparrow et al. 2016). Each domain score has a mean of 100 and an SD of 15, with lower scores indicating lower levels of functioning.

Procedure

Ethical approval was obtained through the Deakin University Human Research Ethics Committee (DURHEC) and the Victorian Department of Education and Training (DET). Following approval, recruitment was conducted through the abovementioned sources. Once recruited, children and parent/caregivers completed baseline assessments. In accordance with the Declaration of Helsinki, all parents of recruited child participants provided written informed consent with children providing assent. During the *pre*-assessment parents completed the demographic survey and parent-report measures and child participants completed age-appropriate Wechsler tests. As Wechsler tests remain valid for two years after their administration additional tests conducted during this time considered invalid. Parents were required to provide a report detailing scores if they already had a valid assessment or had a planned assessment over the study duration. As this study is part of a broader study assessing a range of functional domains, both caregivers and children also completed several additional functional assessments which lie outside the scope of this paper. Each parent and child then completed a follow-up (*post*) assessment within approximately 6–8 weeks of the conclusion of their program. As detailed earlier, the length of each program varies. To account for this, each comparison participant was tested at approximately the same time as an Auskick participant with no significant difference found between the mean number of days between *pre*-and-*post* assessments for each group (refer to Table 1).

Data Analysis

Fisher's exact test and independent samples *t* tests were employed to compare clinical characteristics and levels of physical activity at baseline for the intervention and comparison groups. All significance levels were set to $p < 05$. As per recommendations by O'Keefe (2003), family-wise error rates for subsequent post-hoc analyses were not adjusted given this is a pilot study and doing so reduces statistical power.

Analyses Pertaining to Primary Aims

All primary outcome measures used to examine intervention effectiveness were analysed using 2×2 (group $\times$ time) mixed model analysis of variance (ANOVA) with time as a repeated measure. Scores pertaining to the CBCL total score, DSM-oriented anxiety problems score, and communication demonstrated mild violations of normality. Data were transformed and used in analyses where applicable. If transformed data still violated assumptions, untransformed data were used as there is no non-parametric equivalent to mixed-model ANOVA. It is important that relevant analyses should still be considered within the context of violations. Post-hoc paired samples t-tests were then conducted to assess within-group *pre*-and-*post* differences for variables that demonstrated significant interaction effects.

Analyses Pertaining to Secondary Aims

As the intervention varied in length for each participant, follow up Pearson's product-moment correlations were also conducted to see whether there was a relationship between the *pre-post* difference scores obtained in analyses demonstrating significant group × time interactions, and the number of sessions attended. Significant correlations were then followed up with partial correlations to assess the impact of this relationship when controlling for variables including IQ, ASD severity and adaptive functioning levels. Lastly, independent samples t-test were conducted to see if there were any differences in changes in scores on variables with significant group × time interactions, depending on the type of Auskick program attended (e.g. *mainstream* vs *disability-focused*). Sample size restrictions prevented the *disability-focused* programs to be broken down into the two subtypes. The anxiety problems difference score violated assumptions of normality, as such non-parametric equivalents of the abovementioned tests were adopted.

Results

Sample Characteristics

The two groups did not significantly differ on any sample characteristics (see Table 1). There were also no significant differences between those engaging in *mainstream* Auskick or *disability-focused* programs for the intervention group on the following characteristics: age, IQ, adaptive functioning, and ASD severity. However, 11 parents in the intervention group reported their child was engaging in other community OPA during the football program (swimming, karate, gymnastics, and tennis), compared to five children in the comparison group. The type of activity outside of Auskick that was most frequently engaged in was swimming, and there were no significant differences in the number of children engaging in this activity in each group ($n = 8$ in the intervention; $n = 5$ in the comparison, $p = 0.31$). It is also important to note that it is a requirement that all schools in Victoria, Australia provide swimming education to school-aged children (Victorian Department of Education and Training 2018) and hence participants engaging in swimming were not excluded from the current study.

Independent samples *t* tests were performed to assess group differences at baseline for all variables on the CBCL and VABS. Results indicated no significant differences at baseline for any of the abovementioned variables ($p > 0.05$). Table 2 shows the efficacy of the Auskick intervention in relation to the comparison group for all variables, using a 2 × 2 mixed-model ANOVA. Figure 1 graphs the efficacy of Auskick in relation to the comparison group for variables which reached significance,

Table 2 Pre-and-post intervention scores for all group × time mixed models ANOVAs

	Intervention		Control		Time × group interaction		
	Baseline	Post	Baseline	Post			
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*F*	*p*	η_p^{2a}
CBCL–caregiver							
Total problems[b]	69.32 (7.17)	66.26 (8.17)	66.19 (10.00)	67.38 (7.43)	4.19	.048*	.10
Externalizing problems	63. 42 (10.85)	61.47 (9.68)	62.29 (11.88)	62.48 (8.68)	1.30	.26	.03
Internalizing problems	66.42 (9.29)	62.05 (9.48)	64.05 (10.55)	64.90 (9.23)	6.91	.01*	.15
Social problems ($n = 35$[c])	68.71 (7.16)	64.82 (7.40)	66.44 (7.01)	67.33 (6.92)	6.85	.01*	.17
DSM-oriented scales							
Anxiety problems	68.21 (12.35)	60.95 (9.54)	65.29 (12.26)	66.67 (11.76)	11.95	.001**	.24
Depressive problems	67.63 (9.40)	64.42 (9.58)	65.62 (10.73)	64.52 (10.42)	.72	.40	.02
VABS-3 (n = 37[d])							
Socialization	75.06 (9.01)	74.94 (8.93)	71.25 (10.02)	71.30 (7.04)	.01	.95	.00
Communication	79.35 (10.65)	80.94 (9.44)	75.60 (12.08)	76.05 (11.80)	.17	.69	.01

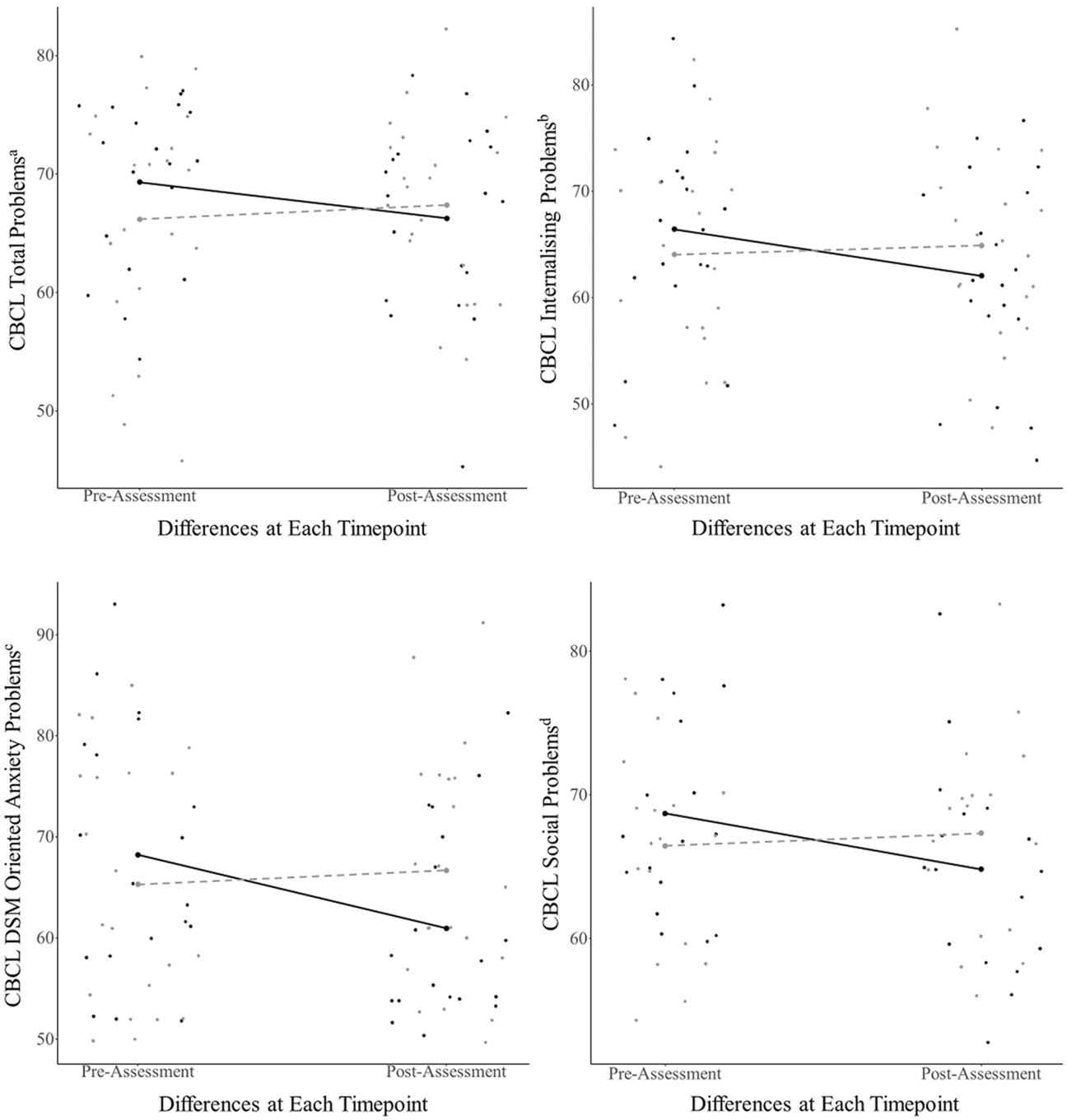
*Significant at the $p \leq .05$ level, **significant at the $p \leq .01$ level

[a]Effect size = partial eta squared

[b]Presented scores represent the raw data whereas the group × time statistics represent transformed data

[c]Sample size is lower as this subscale is not available on the pre-school aged form

[d]Sample size is smaller as not all parents completed this measure



Note: The graph depicting CBCL Total Problems reflects raw data as opposed to transformed
[a] = scores remained in the clinical range
[b] = scores remained in the clinical range
[c] = scores decreased from the borderline clinical range to within the normal range
[d] = scores decreased from the borderline clinical range to within the normal range

Fig. 1 Graphical representations of mean pre-and-post intervention scores and data spread at each time point for variables that reached significance

Child Behavior Checklist: Behavioral and Emotional Functioning

Total Problems

While there were no significant main effects for group or time, there was a significant group × time interaction for *Total* problem behavior scores ($p = 0.048$, $\eta_p^2 = 0.10$ [*pre*- and-*post* scores were transformed using a reflected square root transformation]). Post-hoc repeated measures *t* tests revealed a significant change in transformed scores for the Auskick group $t(18) = -4.52$, $p < 0.001$, with raw scores remaining in the *clinical* range. No significant difference was found in scores for the comparison group $t(20) = -1.14$, $p = 0.27$.

Externalizing and Internalizing Scores

There were no significant group, time or group × time interaction effects for *Externalizing* problems broadband score. Regarding *Internalizing* scores there was no effect for group or time however, was a significant group × time interaction effect ($p = 0.01$, $\eta_p^2 = 0.15$). Post-hoc repeated measures *t* tests revealed a significant reduction in internalizing scores for the Auskick group $t(18) = 2.98$, $p = 0.01$, decreasing from the *clinical* to the *borderline clinical* range. There was no significant change in scores for the control group $t(20) = -0.64$, $p = 0.53$.

DSM-Oriented Anxiety and Depressive Problems

Results indicated no significant time, group or group × time interaction effects for the *DSM-oriented Depressive* problems score. *Anxiety* problems showed no significant main effects for group, however did show both a significant time effect (F [1,38] $= 5.53$, $p = 0.02$, $\eta_p^2 = 0.13$) and group × time interaction ($p = 0.001$, $\eta_p^2 = 0.24$). Post-hoc repeated measures t-tests revealed a significant reduction in anxiety problem scores for the Auskick group, with average scores reducing from the *borderline clinical* to *normal* range $t(18) = 3.85$, $p = 0.001$. There was no significant change in scores for the comparison group $t(20) = -0.83$, $p = 0.41$.

Social Problems

Results with a subset of the sample (6–12-year-old participants [$n = 35$]) indicated no significant main effects for group or time, however a significant group × time interaction effect for *Social* problem scores ($p = 0.01$, $\eta_p^2 = 0.17$). Post-hoc repeated-measures t-tests revealed a significant reduction in scores from the *borderline clinical* to the *normal* range for the Auskick group $t(16) = 2.40$, $p = 0.03$. There was no change in scores for the comparison group $t(17) = -0.99$, $p = 0.34$.

Vineland Adaptive Behavior Scale: Social Functioning and Communication

There were no main effects for group or time, or group × time interaction effects for either socialization or communication (see Table 2).

The Impact of Dosage on Differences Between Each Time Point

Pearson's product-moment correlations were used to assess the relationship between the difference in *pre-post* scores for variables reaching significance on mixed-model ANOVAs, and the number of Auskick sessions attended (see Fig. 2). As per correlational strength guidelines detailed in Evans (1996), a significant, strong negative correlation was found between *Social* problems and the number of Auskick sessions attended ($r = -0.60$, $n = 17$, $p = 0.01$). When controlling for IQ, ASD severity, and adaptive functioning levels, the following partial correlations were found ($r = -0.62$ $p = 0.01$, $r = -0.60$ $p = 0.02$, $r = -0.60$ $p = 0.02$, respectively).

A non-significant, moderate negative correlation was found between *Total* problems and the number of Auskick sessions attended ($r = -0.43$, $n = 19$, $p = 0.07$). Furthermore, a non-significant, weak negative correlation was found between *Internalizing problems* and the number of sessions attended ($r = -0.37$, $n = 19$, $p = 0.12$). As the difference score *Anxiety problems* violated normality, spearman's rho was used. Results indicated a non-significant, weak correlation ($r_s = -0.38$, $n = 19$, $p = 0.11$). As these correlations were not significant, post-hoc partial correlations were not conducted.

The Impact of Attendance in Mainstream or Disability-Focused Auskick Programs

Independent samples *t* tests were conducted to assess the impact of the type of Auskick program attended (*mainstream* vs *disability-focused*) and *pre*-and-*post* difference scores obtained in the intervention group for variables that reached significance. Results revealed no significant group differences for any variables (see Table 3).

Discussion

The current study examined the impact of a popular Australian OPA football program available for children aged between 5 and 12 years, on a behavioral problems

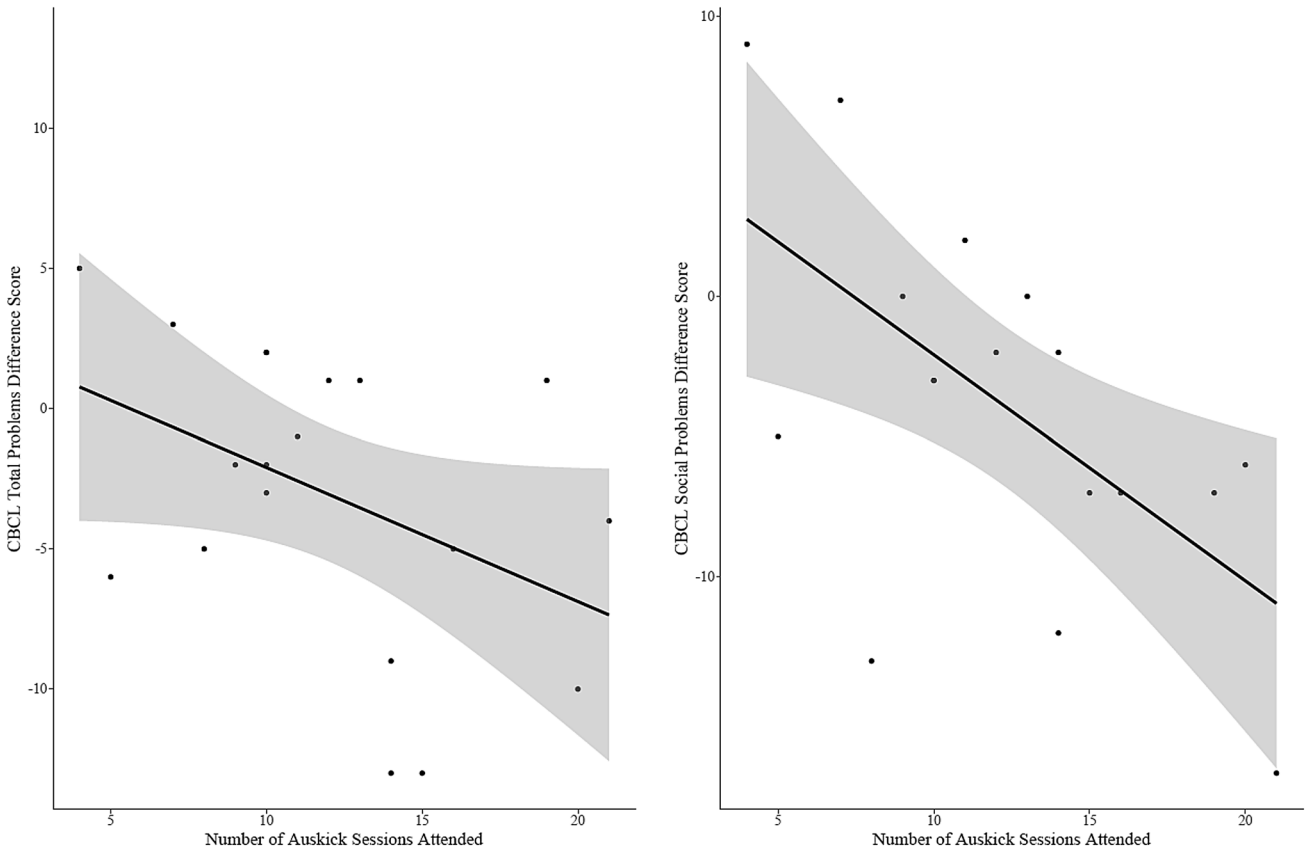


Fig. 2 Graphical representations of moderate or higher correlations between differences scores and number of Auskick sessions attended

Table 3 Differences in pre-post scores for *mainstream* and *disability-focused* programs

	Mainstream *M (SD)*	Disability-focused *M (SD)*	Statistic (*df*)	*p*-value
CBCL—caregiver				
Total problems	− 3.91 (5.09)	− 1.88 (5.72)	− .82 (17)[t]	.43
Internalizing problems	− 5.55 (5.59)	− 2.75 (7.44)	− .94 (17)[t]	.36
Social problems ($n = 17$[a])	− 6.40 (5.25)	− .29 (7.20)	− 2.03 (15)[t]	.06
DSM-oriented anxiety problems	− 8.00[Median]	− 4.00[Median]	38.50[U]	.65

[a]Sample size is lower as this subscale is not available on the pre-school aged form

[t]Comparisons made using an independent samples *t* test

[U]Comparisons made using a Mann–Whitney U-test

measure, the CBCL, and the socialization and communication domains on the VABS-3 in children with ASD. As this study evaluated Auskick as it currently runs within community settings, children attended their local Auskick club (*mainstream* or *disability-focused* programs). Whilst there was a minimum criterion for how many sessions children were required to attend, there was an opportunity to examine dosage due to variation in the lengths of programs children attended. Follow-up analyses were conducted on variables that demonstrated significant group × time interaction effects in primary analyses, to assess the impact of dosage and program type on differences in scores between *pre*-and-*post* sessions. Primary results demonstrated reductions in the CBCL scales total problems, internalizing and DSM-oriented anxiety problems for the intervention group. There was also a reduction in social problems for a subset of children aged 6–12 years. It is important to note however, more parents in the intervention group reported that their child engaged in additional OPA outside the study than in the comparison group, with the difference approaching significance. Consequently, observed results may be due to the combined impact of the football program, and increased

OPA participation more generally. These findings build on the growing literature finding that organized sport participation is associated with greater levels of physical activity (Marques et al. 2016, see Rowland (1998) for contrasting research around the "activity-stat" hypothesis which stipulates that individuals maintain balance in energy expenditure through decreasing activity in one domain, when activity is increased in another).

Behavioral and Emotional Functioning

Results indicated a reduction in parent-reported *Total* problem behaviors (e.g. internalizing, externalizing, social, thought and attention problems) in the intervention group, however no significant change in the comparison group. When investigating the specific location of behavioral changes, there was an interaction effect for *Internalizing* scores. The intervention group showed a significant decrease in internalizing problems whereas the comparison group did not. As mentioned, the subdomains which make up internalizing are not consistent across the two age-group forms. However, when exploring the DSM-orientated scales that were consistent across both forms, a significant effect was found for DSM-oriented *Anxiety* problems. Again, the intervention group showed a significant decrease in scores, with no difference noted in the comparison group. There were no effects shown for *Depressive* problems or *Externalizing* problem scores more broadly. This contrasts with qualitative research exploring a soccer program that suggested reductions in behaviors such as "the reduction of: stereotypes, escape and aggressive behaviors and highly dysfunctional behaviors" (Cei et al. 2017, p. 499). It may be that this type of program specifically (Australian Rules football) does not impact externalizing domains however further quantitative research is needed to explore this area further.

The mechanisms by which physical activity participation may benefit internalizing domains appear multifaceted and are still being explored. Nevertheless, previous research has investigated the positive role exercise has on the monoamines system (including dopamine, noradrenaline, and serotonin) (Meeusen and De Meirleir 1995; Lin and Kuo 2013), which has been implicated in anxiety and is often targeted with medication (i.e. selective serotonin reuptake inhibitors). From a psychological perspective, anxiety itself has been listed as a barrier to participation in physical activity for children with ASD (Engel 2011). Participating in a team sport can also come with sensory challenges such as getting wet, touching mud (May et al. 2017) and loud noises. Research has provided some support for the associations between anxiety and sensory impairments (South and Rodgers 2017; Uljarević et al. 2016). However, exposure to anxiety-provoking situations can often be an effective way of reducing anxiety (for example, exposure therapy (Abramowitz et al. 2019)). Further, sports are said to enhance self-esteem (Lubans et al. 2016) and provide more general health benefits as children are placed in a social environment with peers and adults (Eime et al. 2013). This exposure to social interactions is important given the heightened prevalence rates of social anxiety specifically among this population (Spain et al. 2016; Bellini 2004). It is possible these factors may have contributed to the reduction seen in anxiety in the current study. It would be beneficial for future research into OPA programs to firstly clarify contributions of possible underlying mechanisms to reduce anxiety in children with ASD specifically. Secondly, it would be beneficial to break down anxiety further and examine OPA participation on the subtypes of anxiety (i.e. generalized or social).

Social Functioning and Communication

When assessing results from the VABS-3, there were no significant group × time interaction effects for either *Communication* or *Socialization*, thus indicating these areas did not change following participation in the football program across either group. The result for socialization contrasts Howells et al.'s (2019a) review, however, results for communication are consistent. This is also consistent with the results of other studies who employed the VABS examining OPA programs (for example; horse-riding programs measured in Anderson and Meints (2016) and Gabriels et al. (2015)). As mentioned earlier, one previous study found significant reductions in communication deficits using the Gillam Autism Rating Scale, which measures deficits closely aligned with ASD and the DSM 5 (American Psychiatric Association 2013). It may be that areas such as reading, and writing (which the VABS-3 communication domain includes) may not be influenced by participation in programs such as football, however further research is needed into this type of sports effect on more academically related domains. Future research may benefit from qualitative parent reports around communication as these have the potential to tap into communicative benefits that more clinically oriented measures may not.

Interestingly, for 6–12-year old's, scores pertaining to CBCL *social* problems significantly decreased in the intervention group however no significant difference was seen in the comparison group. The CBCL social problems subscale examines difficulties in relationships and delayed social behaviors (through items such as "easily jealous", "complains of loneliness", "clings to adults or too dependent" and "not liked by other kids") (Achenbach and Rescorla 2001). Moreover, this scale also assesses more movement-related items "gets hurt a lot, accident-prone" and "poorly coordinated or clumsy" (Achenbach and Rescorla 2001). It may be that participation in this activity may have less of an

influence on features that are more core to ASD (for example; emotion recognition and eye contact as is measured on the VABS-3 [which other types of physical activity programs may benefit]). However, it does appear to reduce negative social problems such as feelings of loneliness (which has individually been linked to physical activity participation (Pels and Kleinert 2016)) and clinginess through the group nature of the program. Furthermore, given Auskick and OPA more generally are movement-based activities, it is unsurprising to see benefits in social domains that assess motor-related skills such as clumsiness. However, as this subscale was only available on the 6–18-year-old forms, we cannot apply these results to the 5-year-olds within the sample.

The Impact of Auskick Dosage on Difference Between Each Time Point

Whilst it is difficult to control many aspects of community-based naturalistic research, the variability in season lengths offered by different Auskick centers allowed for quantitative analyses around the number of sessions attended and the difference in scores between *pre*-and-*post* testing. Results indicated a significant, strong negative relationship between the *social* problems difference scores and the number of Auskick sessions attended. This indicates that the more Auskick sessions attended, the greater the reduction in scores from *pre*-to-*post*-testing. This relationship remained strong after controlling for IQ, adaptive functioning levels and ASD severity. One previous study has also reported similar findings, with Karakas et al. (2016) indicating greater scores on teacher-reported social behaviors with the greater time spent engaging in activities (e.g. table tennis, swimming).

Although non-significant relative to the standard alpha level, a moderate negative relationship was also found when examining the *Total* problem difference scores, highlighting that the more Auskick sessions attended, the greater the reduction in total problems. Analyses pertaining to *Internalizing* and *DSM-oriented anxiety* problems found non-significant weak correlations indicating that reductions in scores on these domains were less influenced by the number of sessions attended. It may be that attending only a few Auskick sessions can be beneficial in reducing anxiety, however, given this was a small sample of participants involved in a pilot study, further research is needed to identify the optimal dosage required to achieve a reduction in anxiety and internalizing domains.

Attendance in Mainstream vs Disability-Focused Auskick Programs

When examining differences within the intervention group around the type of program they were engaged in (*mainstream* or *disability-focused*), no differences were noted at baseline in terms of characteristics such as age, IQ, ASD severity and adaptive functioning. Qualitative research has touched on the importance of choice for youth with a disability when deciding to go into segregated sporting programs (Spencer-Cavaliere et al. 2017). However, parents in May et al.'s (2017) sample highlighted the anxiety some parents feel around mainstream participation for reasons such as their child's behavior not being tolerated or their performance not meeting a specific level. In this sample, it may be that parental preferences dictated which type of Auskick program their child participated in, rather than the specific characteristics of that child. It would be interesting for future research to conduct in-depth interviews with parents around why they chose either a segregated or integrated program for their child to participate in.

Furthermore, the level of score reduction between *pre*-and-*post* assessments seen in children who participated in mainstream Auskick was not different from the reduction in scores seen in those who were part of *disability-focused* programs for all variables which demonstrated significant interaction effects. Whilst the social problems subdomain demonstrated a greater reduction in scores for mainstream programs compared to *disability-focused*, this difference was not significant. Nevertheless, it has been said that integration into mainstream schooling settings provides an opportunity for typically developing children to act as role models and children with ASD are provided with more of a chance to mimic social skills and learn social rules which can improve mental health (Mundy and Mastergeorge 2012). However, for the remaining areas (total, internalizing and anxiety problems), participation in either segregated or unsegregated programs within the community appears to produce similar reductions. As mentioned earlier, *disability-focused* programs can be broken down into disability-specific and side-by-side programs. The sample size of the intervention group did not permit analyses breaking the *disability-focused* group down further. Future research should consider further examining integrated vs segregated programs to examine the impact the different types of programs may have.

Limitations and Recommendations for Future Research

It has been suggested that research conducted in schools or the community may be "more ecologically valid, and have greater external validity and transferability than a tightly controlled RCT" (Bishop and Pangelinan 2018, p. 22). While it is not possible to randomize or wait-list control for a study investigating the benefits of community-based sports that participants voluntarily enrolled in, we have been able to use a scientific framework to understand potential benefits of OPA for a group of children with ASD using

similar pre-post methodology as applied in previous RCTs evaluating OPA programs (e.g. Gabriels et al. 2015). However, we do acknowledge that a lack of randomization as a limitation that can lead to systematic differences between the groups (Sibbald and Roland 1998). This may have affected, for example, more children engaging in OPA outside the study in the intervention group. Further limitations of this study include the use of unblinded, caregiver reports, which are prone to placebo (Waschbusch et al. 2009). Future research into this program may benefit from including more independent raters (e.g. teacher measures), which may give more information about potential changes across settings. Research may also benefit from using more objective measures where possible, for example; as seen in Hillier et al. (2011), salivary cortisol levels can be collected *pre*-and-*post* intervention as a marker for stress/anxiety levels.

Due to the nature of this naturalistic study design, we were not able to control for engagement in usual routines (inclusive of therapy and medication). The influence these factors may have on results remains unclear. It is important to note the variability which surrounded the *pre*-and-*post* data (refer to Fig. 1) and a more methodologically rigorous design may have reduced some of this variability. Furthermore, to the best of our knowledge, this is the largest evaluation of a team football program to be evaluated for children with ASD, however, the sample size was still modest. As indicated by Rinehart et al. (2018), larger, practical RCTs are needed in this area to determine the efficacy of community OPA programs. Future research should aim to employ more robust techniques within naturalistic settings e.g. randomizing participants and more closely controlling for confounds such as OPA and physical activity levels outside of the program.

Conclusions

The findings from this pilot show positive indications of community-based football, specifically Australian Rules football programs (Auskick) for children with ASD. More specifically, results indicated significant decreases in CBCL *total* problem behaviors, *internalizing* and *DSM*-oriented anxiety problem behaviors for the intervention (Auskick) group and no significant changes for the comparison group *pre*-and-*post*. A significant decrease in social problems on the CBCL was also found for a subset of the intervention group (6–12-year-olds), which encompasses negative indicators of social experiences such as loneliness and motor-social areas such as clumsiness. These results suggest that Auskick and more generally greater OPA participation may help alleviate anxiety symptomology in children with ASD, where the co-morbidity of clinically significant anxiety it high (Gillott et al. 2001; Van Steensel et al. 2011). Nevertheless, further, more rigorous research is still needed in this area. As acknowledged by Rinehart et al (2018), research into such programs has the potential to benefit not only children but their families and communities alike.

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Author Contributions KH, CS, EL, CH, JM, AW and NR were involved in the conception of this paper. KH, CS, EL and NR were involved in participant recruitment and data collection. KH, EL, CH and NR were involved in data analysis. All authors contributed to the preparation of the manuscript for publication. All authors approved the final manuscript.

Compliance with Ethical Standards

Conflicts of interest NR and JM received philanthropic funding from Moose Toys, MECCA Brands, the Wenig Family, Geelong Community Foundation, and Grace & Emilio Foundation; and industry partner funding from the Victorian Department of Education, to conduct research in the field of neurodevelopmental disorders and inclusion. NR, CH and JM also received funding from the Ferrero Group Australia as part of its Kinder + Sport pillar of Corporate Social Responsibility initiatives. NR and JM have also previously received scholarship funding from the Australian Football League and industry partner funding from the NDIS. NR has received donations from Vic Health and Bus Association Victoria; and previous speaker honorarium from Novartis (2002), Pfizer (2006) and Nutricia (2007); and is a Director of the Amaze Board (Autism Victoria). None of the companies, industry partners or organizational bodies listed above had a role in this research including the collection, analysis, and interpretation of data; in writing of the manuscript; and /or in the decision to submit the article for publication. No other authors report conflicts of interest.

Ethical Approval All procedures performed in this study were done so in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

Abramowitz, J. S., Deacon, B. J., & Whiteside, S. P. (2019). *Exposure therapy for anxiety: Principles and practice*. New York: Guilford Publications.

Achenbach, T. M., Dumenci, L., & Rescorla, L. A. (2003). DSM-oriented and empirically based approaches to constructing scales from the same item pools. *Journal of Clinical Child and Adolescent Psychology, 32*(3), 328–340.

Achenbach, T. M., & Rescorla, L. A. (2000). *Manual for the ASEBA preschool forms & profiles: An integrated system of*

multi-informant assessment; Child behavior checklist for ages 1 1/2–5; Language development survey; Caregiver-teacher report form. Burlington: University of Vermont.

Achenbach, T. M., & Rescorla, L. (2001). *ASEBA school-age forms & profiles*. Burlington, VT: Aseba.

AllPlay Footy. (2018). About, Retrieved October 21, 2019, from https://allplayfooty.org.au/about/.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders—DSM IV*. Arlington, VA: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders—DSM 5*. Arlington, VA: American Psychiatric Publishing.

Anderson, S., & Meints, K. (2016). Brief report: The effects of equine-assisted activities on the social functioning in children and adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*(10), 3344–3352. https://doi.org/10.1007/s10803-016-2869-3.

Australian Bureau of Statistics. (2013). Stats & facts: Sport and physical recreaction—Differentials in participation. Retrieved August 5, 2019, from https://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/4156.0.55.001Main%20Features5Nov%202013?opendocument&tabname=Summary&prodno=4156.0.55.001&issue=Nov%202013&num=&view=.

Australian Football League (AFL). (2019). Learning AFL, Australian football today. Retrieved July 31, 2019, from https://www.afl.com.au/afl-hq/the-afl-explained/afl-football-today.

Australian Football League (AFL) Victoria. (2016). Access all abilities Auskick. Retrieved August 5, 2019, from https://aflvic.com.au/auskick/access-abilities-auskick/.

Bahrami, F., Movahedi, A., Marandi, S. M., & Sorensen, C. (2016). The effect of karate techniques training on communication deficit of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 46*(3), 978–986.

Bellini, S. (2004). Social skill deficits and anxiety in high-functioning adolescents with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 19*(2), 78–86.

Bishop, J. C., & Pangelinan, M. (2018). Motor skills intervention research of children with disabilities. *Research in Developmental Disabilities, 74*, 14–30.

Bramham, J., Morris, R., Hornak, J., Bullock, P., & Polkey, C. (2009). Social and emotional functioning following bilateral and unilateral neurosurgical prefrontal cortex lesions. *Journal of Neuropsychology, 3*(1), 125–143.

Cei, A., Franceschi, P., Rosci, M., Sepio, D., & Ruscello, B. (2017). Motor and psychosocial development in children with autism spectrum disorder through soccer. *International Journal of Sport Psychology, 48*(5), 485–507.

Chandler, S., Howlin, P., Simonoff, E., O'sullivan, T., Tseng, E., Kennedy, J., et al. (2016). Emotional and behavioural problems in young children with autism spectrum disorder. *Developmental Medicine & Child Neurology, 58*(2), 202–208.

Constantino, J. N., & Gruber, C. P. (2012). *Social responsiveness scale, second edition (SRS-2) [Manual]*. Torrance, CA: Western Psychological Services.

Dimech, A. S., & Seiler, R. (2011). Extra-curricular sport participation: A potential buffer against social anxiety symptoms in primary school children. *Psychology of Sport and Exercise, 12*(4), 347–354.

Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 98.

Engel, A. (2011). *Physical activity participation in children with autism spectrum disorders: An exploratory study*. Citeseer

Evans, J. D. (1996). *Straightforward statistics for the behavioral sciences*. Belmont: Thomson Brooks/Cole Publishing Co.

Fournier, K. A., Hass, C. J., Naik, S. K., Lodha, N., & Cauraugh, J. H. (2010). Motor coordination in autism spectrum disorders: A synthesis and meta-analysis. *Journal of Autism & Developmental Disorders, 40*(10), 1227–1240. https://doi.org/10.1007/s10803-010-0981-3.

Gabriels, R., Pan, Z., Dechant, B., Agnew, J. A., Brim, N., & Mesibov, G. (2015). Randomized controlled trial of therapeutic horseback riding in children and adolescents with autism spectrum disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(7), 541–549.

García-Gómez, A., Risco, M. L., Rubio, J. C., Guerrero, E., & García-Peña, I. M. (2014). Effects of a program of adapted therapeutic horse-riding in a group of autism spectrum disorder children. *Electronic Journal of Research in Educational Psychology, 12*(1), 107–128.

Gillott, A., Furniss, F., & Walter, A. (2001). Anxiety in high-functioning children with autism. *Autism, 5*(3), 277–286.

Hayward, L. M., Fragala-Pinkham, M., Johnson, K., & Torres, A. (2016). A community based, adaptive soccer program for children with Autism: Design, implementation and evaluation. *Palaestra, 30*(4), 44–50.

Healy, S., Nacario, A., Braithwaite, R. E., & Hopper, C. (2018). The effect of physical activity interventions on youth with autism spectrum disorder: A meta-analysis. *Autism Research, 11*, 818–833.

Hillier, A., Murphy, D., & Ferrara, C. (2011). A pilot study: short-term reduction in salivary cortisol following low level physical exercise and relaxation among adolescents and young adults on the Autism spectrum. *Stress and Health, 27*(5), 395–402.

Howells, K., Sivaratnam, C., May, T., Lindor, E., McGillivray, J., & Rinehart, N. (2019a). Efficacy of group-based organised physical activity participation for social outcomes in children with autism spectrum disorder: A systematic review and meta-analysis. *Journal of Autism & Developmental Disorders, 49*(8), 3290–3308. https://doi.org/10.1007/s10803-019-04050-9.

Howells, K., Sivaratnam, C., May, T., Lindor, E., & Rinehart, N. (2019b). A pilot acceptability study of an 'AllPlay pre-learn' day program to facilitate participation in organised physical activity for children with disabilities. *International Journal of Environmental Research and Public Health, 16*(24), 5058.

Ivanova, M. Y., Achenbach, T. M., Rescorla, L. A., Harder, V. S., Ang, R. P., Bilenberg, N., et al. (2010). Preschool psychopathology reported by parents in 23 societies: testing the seven-syndrome model of the child behavior checklist for ages 15–5. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(12), 1215–1224.

Kallings, L. V., Leijon, M., Hellénius, M. L., & Ståhle, A. (2008). Physical activity on prescription in primary health care: A follow-up of physical activity level and quality of life. *Scandinavian Journal of Medicine & Science in Sports, 18*(2), 154–161.

Karakas, G., Yilmaz, A., & Kaya, H. B. (2016). Teachers comments by 5–6 age children with autism spectrum disorders and behaviour of the effect of social skills level sports. *Journal of Physical Education & Sports Science/Beden Egitimi ve Spor Bilimleri Dergisi, 10*(2).

Kazdin, A. E. (2019). Annual research review: Expanding mental health services through novel models of intervention delivery. *Journal of Child Psychology and Psychiatry, 60*(4), 455–472.

Lang, R., Koegel, L. K., Ashbaugh, K., Regester, A., Ence, W., & Smith, W. (2010). Physical exercise and individuals with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 4*(4), 565–576. https://doi.org/10.1016/j.rasd.2010.01.006.

Lin, T.-W., & Kuo, Y.-M. (2013). Exercise benefits brain function: the monoamine connection. *Brain Sciences, 3*(1), 39–53.
Liu, T., & Breslin, C. M. (2013). Fine and gross motor performance of the MABC-2 by children with autism spectrum disorder and typically developing children. *Research in Autism Spectrum Disorders, 7*(10), 1244–1249.
Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., et al. (2016). Physical activity for cognitive and mental health in youth: A systematic review of mechanisms. *Pediatrics, 138*(3), e20161642.
MacDonald, M., Lord, C., & Ulrich, D. A. (2013). The relationship of motor skills and social communicative skills in school-aged children with autism spectrum disorder. *Adapted Physical Activity Quarterly, 30*(3), 271–282.
Marques, A., Ekelund, U., & Sardinha, L. B. (2016). Associations between organized sports participation and objectively measured physical activity, sedentary time and weight status in youth. *Journal Of Science And Medicine In Sport, 19*(2), 154–157.
Matson, J. L., & Nebel-Schwalm, M. S. (2007). Comorbid psychopathology with autism spectrum disorder in children: An overview. *Research in Developmental Disabilities, 28*(4), 341–352. https://doi.org/10.1016/j.ridd.2005.12.004.
May, T., Barnett, L., Hinkley, T., McGillivray, J., Skouteris, H., Stephens, D., et al. (2017). 'We're doing AFL Auskick as well': Experiences of an adapted football program for children with autism. *Journal of Motor Learning and Development, 6*(1), 130–146.
Meeusen, R., & De Meirleir, K. (1995). Exercise and brain neurotransmission. *Sports Medicine, 20*(3), 160–188.
Mundy, P. C., & Mastergeorge, A. (2012). *Educational interventions for students with autism*. New York: Wiley.
O'Keefe, D. J. (2003). Colloquy: Should familywise alpha be adjusted? Against familywise alpha adjustment. *Human Communication Research, 29*(3), 431–447.
Obrusnikova, I., & Cavalier, A. R. (2011). Perceived barriers and facilitators of participation in after-school physical activity by children with autism spectrum disorders. *Journal of Developmental and Physical Disabilities, 23*(3), 195–211.
Okely, A. D. (1999). *The relationship of participation in organised sports and games, participation in nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents*. Michigan: University of Wollongong.
Papadopoulos, N., McGinley, J., Tonge, B., Bradshaw, J., Saunders, K., Murphy, A., et al. (2012). Motor proficiency and emotional/behavioural disturbance in autism and Asperger's disorder: another piece of the neurological puzzle? *Autism, 16*(6), 627–640.
Pels, F., & Kleinert, J. (2016). Loneliness and physical activity: A systematic review. *International Review of Sport and Exercise Psychology, 9*(1), 231–260.
Rinehart, N. J., Jeste, S., & Wilson, R. B. (2018). Organized physical activity programs: Improving motor and non-motor symptoms in neurodevelopmental disorders. *Developmental Medicine And Child Neurology*. https://doi.org/10.1111/dmcn.13962.
Rowland, T. W. (1998). The biological basis of physical activity. *Medicine and Science in Sports and Exercise, 30*(3), 392–399.
Sibbald, B., & Roland, M. (1998). Understanding controlled trials Why are randomised controlled trials important? *BMJ British Medical Journal, 316*(7126), 201.
Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry, 47*(8), 921–929.
Sivaratnam, C. S., Newman, L. K., Tonge, B. J., & Rinehart, N. J. (2015). Attachment and emotion processing in children with autism spectrum disorders: Neurobiological, neuroendocrine, and neurocognitive considerations. *Review Journal of Autism and Developmental Disorders, 2*(2), 222–242. https://doi.org/10.1007/s40489-015-0048-7.
Smith, A. (2005). Junior sport participation programs in Australia. *Youth Studies Australia, 24*(1), 54–59.
Sorensen, C., & Zarrett, N. (2014). Benefits of physical activity for adolescents with autism spectrum disorders: A comprehensive review. *Review Journal of Autism and Developmental Disorders, 1*(4), 344.
South, M., & Rodgers, J. (2017). Sensory, emotional and cognitive contributions to anxiety in autism spectrum disorders. *Frontiers in Human Neuroscience, 11*, 20.
Spain, D., Happé, F., Johnston, P., Campbell, M., Sin, J., Daly, E., et al. (2016). Social anxiety in adult males with autism spectrum disorders. *Research in Autism Spectrum Disorders, 32*, 13–23.
Sparrow, S. S., Cicchetti, D. V., & Saulnier, C. A. (2016). *Vineland-3: Vineland adaptive behavior scales*. Toronto: PsychCorp.
Spencer-Cavaliere, N., Thai, J., & Kingsley, B. (2017). A part of and apart from sport: Practitioners' experiences coaching in segregated youth sport. *Social Inclusion, 5*(2), 120–129.
Tonge, B. J., Brereton, A. V., Gray, K. M., & Einfeld, S. L. (1999). Behavioural and emotional disturbance in high-functioning autism and Asperger syndrome. *Autism, 3*(2), 117–130.
Uljarević, M., Lane, A., Kelly, A., & Leekam, S. (2016). Sensory subtypes and anxiety in older children and adolescents with autism spectrum disorder. *Autism Research, 9*(10), 1073–1078.
Van Steensel, F. J., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: A meta-analysis. *Clinical Child and Family Psychology Review, 14*(3), 302.
Victorian Department of Education and Training. (2018). Swimming and water safety education. Retrieved August 5, 2019, from https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/physed/Pages/swimmingsafety.aspx
Waschbusch, D. A., Pelham, W. E., Jr., Waxmonsky, J., & Johnston, C. (2009). Are there placebo effects in the medication treatment of children with attention-deficit hyperactivity disorder? *Journal of Developmental & Behavioral Pediatrics, 30*(2), 158–168.
Wechsler. (2012). Wechsler Preschool and Primary of Intelligence-Fourth Edition Australian and New Zealand (WPPSI-IV-A&NZ).
Wechsler, D. (2011). *Wechsler abbreviated scale of intelligence, Second Edition (WASI-II)*. San Antonio, TX: NCS Pearson. https://doi.org/10.1177/0734282912467756
Wechsler, D. (2014). *Wechsler Intelligence Scale for Children (WISC-V): Technical and interpretive manual*. Bloomington, MN: NCS Pearson, Incorporated.