Norman Mackenzie Z. (Orcid ID: 0000-0003-2098-1582)
Knickmeyer Rebecca (Orcid ID: 0000-0001-7708-1388)

Turner Syndrome and Psychosocial Interventions: Recommendations for Collaborative Communication Between Medical and School Teams

Mackenzie Z. Norman[a], Christa Hutaff-Lee[b], Rebecca C. Knickmeyer[c,d], Doris Fadoju[e], Jeanne Wolstencroft[f], David S. Hong[g], David E. Sandberg[h]

[a] Pediatric Psychology, Oregon Health & Science University, Portland, Oregon, normamac@ohsu.edu, https://orcid.org/0000-0003-2098-1582
[b] Department of Pediatrics, University of Colorado School of Medicine and eXtraOrdinarY Kids Clinic, Children's Hospital Colorado, Aurora, Colorado, christa.hutaff-lee@childrenscolorado.org, https://orcid.org/0009-0000-4591-1025
[c] Department of Pediatrics and Human Development, Michigan State University, East Lansing, Michigan, knickmey@msu.edu, https://orcid.org/0000-0001-7708-1388
[d] Institute for Quantitative Health Science and Engineering, Michigan State University, East Lansing, Michigan, knickmey@msu.edu, https://orcid.org/0000-0001-7708-1388
[e] Department of Pediatrics, Division of Endocrinology, Emory University School of Medicine/Children's' Healthcare of Atlanta, Atlanta, Georgia, doris.o.fadoju@emory.edu, https://orcid.org/0000-0002-8117-8438
[f] Great Ormond Street Institute of Child Health, University College London, London, United Kingdom, j.wolstencroft@ucl.ac.uk, https://orcid.org/0000-0001-6160-9731
[g] Division of Interdisciplinary Brain Sciences and Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford, California, dshong@stanford.edu, https://orcid.org/0000-0001-9515-881X
[h] Department of Pediatrics, Susan B. Meister Child Health Evaluation and Research (CHEAR) Center, University of Michigan Medical School, Ann Arbor, Michigan, dsandber@med.umich.edu, https://orcid.org/0000-0002-7389-8283

Corresponding Author & Contact Information: Mackenzie Z. Norman, PhD;

normamac@ohsu.edu

Acknowledgements: We thank Zoe Lapham for her assistance in design of the Turner Syndrome School Support Plan.

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/ajmg.c.32134

This article is protected by copyright. All rights reserved.

Author Manuscript

Grant Funding: DES was supported, in part, by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development award R01HD093450. DSH was supported, in part, by a National Institute of Health grant.

Disclosures: DSH is on the Advisory Board for ParentLab, Inc.

Author Contribution Statement: Mackenzie Z. Norman: Conceptualization, writing original draft, development of support plan, reviewing and editing. Christa Hutaff-Lee: Writing of introduction, reviewing and editing. Rebecca C. Knickmeyer: Writing of introduction, reviewing and editing. Doris Fadoju: Writing of introduction, reviewing and editing. Jeanne Wolstencroft: Development of support plan, reviewing and editing. David S. Hong: Reviewing and editing. David E. Sandberg: Conceptualization, reviewing and editing.

Data Availability Statement: Data sharing not applicable – no new data generated.

Author Manuscript

Author Manuscript

Abstract

Individuals with Turner Syndrome (TS) can experience not only physical and medical differences but are also at risk for neurocognitive and associated psychosocial challenges. Specifically, research shows increased likelihood of difficulties with visual-spatial reasoning, executive functioning, attention, and mathematics skills. One emerging area of research focuses on deficits in social skills and increased prevalence of anxiety within this population. This review introduces relevant genetic influences of TS and examines existing research on social skills and anxiety in individuals with TS. The importance of collaboration between the medical team and school personnel for patients with TS is emphasized, and specific clinical recommendations, such as the use of the TS School Support Plan, are provided to facilitate this collaboration. This paper services as a brief introduction to orient the reader to considerations of strengthening collaboration between medical and school systems; however, future research is needed to investigate the effectiveness and acceptability of the School Support Plan to enhance liaison between the patient's medical and school teams.

Keywords: Turner Syndrome; social skills; anxiety; psychosocial interventions; medical-school collaboration; psychology

Author Manuscript

Turner Syndrome and Psychosocial Interventions: Recommendations for Collaborative Communication Between Medical and School Teams

Turner Syndrome (TS) is a genetic condition caused by the complete or partial absence of one copy of the X chromosome in phenotypic females (Hong & Reiss, 2014). The most common karyotype is 45,X, accounting for about 40-50% of cases. In 15-25% of cases, individuals may have mosaicism (e.g., 45,X/46,XX or 45,X/46,XY) or structural abnormalities such as ring chromosomes, isochromosomes, or deletions in 20% of cases. Research has shown that the X chromosome contains several genes integral to typical cognitive and social functioning. Therefore, loss of one X chromosome or structural changes that result in disruption of certain X-linked genes results in variable presentations (Viuff et al., 2019).

The neurocognitive profile of individuals with TS varies significantly across individuals. Overall intellectual functioning for the majority of individuals with TS is within the average range; however, in many individuals there is a well-documented discrepancy between verbal intellectual abilities and nonverbal/visual-spatial intellectual abilities (Pennington, et al., 1985). This classically described discrepancy between verbal IQ and performance IQ is more often seen in individuals with the 45,X karyotype. Studies have indicated that presence of a ring X chromosome has been associated with significant learning difficulties and cognitive impairment (Kuntsi, et al, 2000). An estimated 5-10% of individuals with TS will have intellectual abilities within the intellectual disability disorder range (Bispo et al., 2013). Furthermore, impairment of visual spatial abilities has been linked to ~10 Mb deletions of the distal Xp in patients with non-mosaic deletions of the X chromosome (Ross, et al., 2000). Some individuals with isochromosome Xq have more pronounced cognitive deficits compared to other karyotypes but higher verbal IQ (Messina, et al., 2007).

Author Manuscript

Individuals with TS are at risk for vulnerabilities in a number of areas. Domains typically affected include working memory, executive function, social cognition, perceptual motor and visual spatial skills, attention, language and academic achievement. This classic profile typically emerges during the school-age years. In the infancy and preschool period, children with TS are very similar to peers with typical chromosome complements in terms of cognition, temperament, and adaptive function, though they may demonstrate some motor difficulties, including reduced oral motor skills leading to feeding challenges (Pretzel et al., 2020; Reinhartsen et al., 2021). There is an increased risk for a number of different neurodevelopmental disorders including attention-deficit/hyperactivity disorder (ADHD) and specific learning disability in mathematics (dyscalculia). Approximately 7-25 percent of individuals with TS will meet criteria for ADHD (Green et al., 2017; Russell et al., 2006). Presentation of ADHD symptoms may change over the lifespan, with increased hyperactive/impulsive symptoms noted during childhood and more inattentive features noted during later childhood, adolescence and adulthood. Many individuals benefit from formal school/vocational-based accommodations for associated vulnerabilities in attention, distractibility, processing speed, and executive functioning skills. Clinical management should also include consideration of medications to treat attentional difficulties. Academically, relative strengths are typically observed in reading and spelling skills, with well-documented vulnerabilities in math calculation and math reasoning skills noted for many individuals with TS, with some level of math difficulties documented in up to 75 percent of individuals (Mazzocco, 2009). In addition, a percentage of individuals may experience difficulties with reading comprehension requiring abstract reasoning (e.g., forming hypotheses) or written expression. Writing difficulties stem from increased risk for motor difficulties (Hong & Reiss, 2014) and executive functioning skills required for planning and organization of written documents.

Author Manuscript

Academic intervention services (i.e., tutoring) as well as compensatory tools (e.g., use of a calculator, extended time, voice dictation software) are recommended in school environments. School-aged children may also benefit from participation in occupational therapy to assist with handwriting development. Finally, vulnerabilities in visual-spatial skills have also been well documented in individuals with TS and can further exacerbate underlying math vulnerabilities. Recent clinical practice has focused on using the diagnostic label of Neurocognitive Disorder secondary to a medical condition (ICD-10-CM Diagnosis Code F06.7) to capture the constellation of neurocognitive, social, and emotional vulnerabilities that may be observed in individuals with TS. This label is often used when an individual does not meet full diagnostic criteria for another neurodevelopmental disorder (e.g., ADHD) or to specify additional cognitive vulnerabilities that do not currently have a recognized diagnostic label (e.g., weaknesses in nonverbal and visual spatial skills).

Psychological wellbeing can also be affected resulting in anxiety, poor peer relationships, social emotional maladaptation and difficulty with initiating or maintaining peer relationships (Hong & Reiss, 2014; Wolstencroft & Skuse, 2019). Understanding these genetic influences can help guide early interventions and support tailored educational strategies for individuals with TS to improve cognitive and social outcomes.

Turner Syndrome and Social Skills

Research indicates that individuals with TS often have difficulty understanding social cues and displaying appropriate social responses (Hong et al., 2011; McCauley et al., 2001; Wolstencroft & Skuse, 2018). These difficulties with social skills are present from childhood but often become more apparent during adolescence, when social interactions become increasingly complex (Wolstencroft et al., 2020). A study conducted by Hong and colleagues (2011)

Author Manuscript

investigated components of social competence and cognition in a pre-estrogen sample of girls ages 3 to 12 years (including girls with TS and typically developing controls). Results indicated that girls with TS showed overall challenges with social competence and exhibited mild-to-moderate clinical concerns on the Social Cognition and Autistic Mannerisms domains of the Social Responsiveness Scale (SRS-2). In this study, girls with TS also exhibited deficits in ability to detect reciprocal and social behaviors and use expressive social communication. Of note, however, researchers found no difference in scores on the Social Motivation subscale between girls with TS and their typically developing peers. Previous research has pointed to the fact that self-esteem in girls with TS tends to decrease over time (Kilic et al., 2005). This observation of typical scores on the Social Motivation subscale could help explain the link between impaired social performance and decreases in self-esteem. Specifically, individuals with TS experience typical levels of motivation to engage in social situations but may experience difficulties successfully navigating social situations due to social skills challenges. Repeated experiences of unsuccessful social performances could be related to decreases in self-esteem across time.

These social skills difficulties persist into adulthood. Adult women with TS report having fewer close friendships and relationships and report feeling social isolation. Wolstencroft and colleagues (2020) conducted semi-structured interviews and questionnaires with young women with TS. Results from qualitative data showed that women reported feeling increasingly “out of sync” with their peers and furthermore, on a scale of autistic traits, with half of the participants falling in the mid to severe autistic traits range on the SRS-2 (as rated by parents). Qualitative data from this study highlighted difficulties navigating nuanced social interactions. For example, one participant stated “I’ll probably get it wrong as judging by facial expressions. It’s hard to know when to speak, when to let others, when to give something or when to sit back. When

someone else is talking it's hard to find a balance, it's a bit hard to figure it out" (Wolstencroft et al., 2020, p. 51). Additionally, research suggests that these differences in social skills and communication may overlap with symptoms of autism spectrum disorder (ASD). Wolstencroft and colleagues (2022) conducted a study that included 127 girls with TS, ages 5-18 years. Researchers obtained reports of participant mental health using a diagnostic interview with parents (The Development and Wellbeing Assessment or DAWBA), the Strengths and Difficulties Questionnaire (SDQ), and the Social Responsiveness Scale (SRS-2). On both the SRS-2 and the SDQ, about 60% of parents reported that their daughter experienced some level of social difficulties ranging from mild to severe and approximately 23%, or one in four participants, met diagnostic criteria for ASD based on parent report. Interestingly, individuals with TS in this study had a much more positive view of their social experiences than their parents with only 4% reporting high or very high peer difficulties on the SDQ. An elevated risk for ASD was also reported by Björlin Avdic and colleagues (2021), though the overall prevalence was substantially lower: in a retrospective cohort study of females with TS (n = 1392), identified through the Swedish National Patient Register, results indicated that TS was associated with a fourfold increased risk of ASD compared with age- and sex-matched controls from the general population (Björlin Avdic et al., 2021); this corresponded to approximately 2% of females with TS in the register or one in fifty individuals.

Turner Syndrome and Anxiety

Research has indicated that individuals with TS may have an increased risk for anxiety compared to the general population (Cardoso et al., 2004; Kilic et al., 2005); however, there is inconsistent evidence in this area as other research suggests individuals with TS have a diagnosed anxiety disorder at a similar prevalence rate as the general pediatric population

Author Manuscript

Author Manuscript

(Kremen et al., 2023). It is plausible that these inconsistencies could be partially explained by differences in informant. Specifically, several studies have found that individuals with TS tend to report less social performance difficulties than their parents report (Lagrou et al., 1998; Suzigan et al., 2011), which may be related to a conflation between social knowledge and social performance (see Wolstencroft, 2019 for additional discussion). Regardless of prevalence rates, individuals with TS and their families consistently report anxiety as an important area of concern. In fact, in a study that asked participants about priorities for research, 84% of women with TS and 91% of their parents reported that research on emotional and behavioral problems was very important (Sandberg et al., 2019). Carl and colleagues (2024) conducted a study to better understand anxiety symptomatology, diagnosis, and care in those with TS. Using a mixed methods design, findings indicated the majority of participants noted that anxiety symptoms occurred two or more days per week and reported experiencing anxious mood more often at school or work. Additionally, results showed that anxiety symptoms and triggers changed across the lifespan and symptoms were oftentimes undiagnosed and/or untreated in childhood. These findings are in line with research from the general population in which studies show that the majority of adolescents with social anxiety disorder are likely to remain untreated (Burstein et al., 2011; Masia Warner et al., 2007). Taken together, this points to the need to consider how to increase access to care for individuals with TS experiencing symptoms of anxiety. We next explore interventions that potentially ameliorate the socioemotional challenges observed in TS and how schools might be an ideal setting to help meet the mental health, including social skills needs of this population.

Psychosocial Interventions: Social Skills

Author Manuscript

In line with the research pointing to deficits in social skills and the prevalence of anxiety in this population, it is important to first understand what treatment modalities may be effective. Robust evidence from international randomized controlled trails shows that social skills training interventions, like the Program for the Education and Enrichment of Relational Skills (PEERS; Laugeson & Frankel, 2011) improves social capabilities in individuals with ASD, ADHD, anxiety, and depression. This manualized treatment program is delivered in group sessions across 14-16 weeks, and sessions include both didactic instruction in addition to social skills rehearsal on topics such as conversational skills, developing friendships, entering and exiting conversations, handling teasing, and resolving conflict. Wolstencroft and colleagues (2021) conducted a feasibility study of using the PEERS program with girls and young women with TS that lived throughout the south of England. Findings in this sample showed that PEERS was feasible and was rated as highly acceptable amongst both participants and parents. Furthermore, PEERS showed promise in improving social outcomes with most improvements in changes in social knowledge and increases in participant-arranged get-togethers. While this study is highly promising in terms of the ability to use existing interventions with minimal adaptations for girls and young women with TS, more research is needed to better understand how other interventions might work for this population.

Simultaneously, it is important to understand how to improve access to these interventions for individuals with TS. Not all families live near a hospital with TS specialty providers, which limits how often they can visit the hospital or clinical setting for psychosocial interventions/treatment. However, children spend a vast majority of their time in the school setting. This places school staff (e.g., teachers, school psychologists, social workers, school nurses, etc.) in a position to be able to support the psychosocial needs of students with TS.

Author Manuscript

Schools provide a unique setting where the majority of youth can be reached, making them an ideal platform for interventions that address the mental health needs of children and adolescents. Implementing such interventions within the school system improves access to care while also being cost-effective. Additionally, the treatment of social skills lends itself to the school setting. That is, the school environment allows for opportunities for in-vivo exposures to situations that are often avoided. For example, scenarios like answering a question in class, eating lunch with classmates in the cafeteria, initiating conversations with peers, and asking a teacher for help on an assignment can all be practiced in the school setting. Treatment for social skills in schools allows students to practice navigating these situations in real time using the skills they learn in group treatment. Additionally, peers and teachers that students routinely interact with can help support students' progress by participating in some of the group sessions or exposures. Relatedly, teachers can embed social learning objectives into regular academic lessons (see Zuniga, 2019 for recommendations specifically for students with TS). As noted by Ryan and Masia Warner (2012), delivering treatment in a real-world setting can help increase the likelihood that treatment gains are generalized to other situations and environments. This addresses a challenge that has been noted in research on social skills intervention for youth with ASD in that skills learned and practiced in laboratory/research or clinic settings may not always be applied in day-to-day life in the school or home settings (Reichow and Volkmar 2010).

Understanding the research on school-based interventions is crucial for identifying those that may be applicable to individuals with TS in this setting. Laugeson and colleagues (2014) conducted a study in which the PEERS program was implemented in the school system (see also Yoo et al., 2014 for a RCT of the Korean Version of PEERS). Middle school students with ASD (n = 73) and their parents and teachers were included. Participants were assigned to either the

Author Manuscript

PEERS treatment condition or an alternative social skills curriculum. Results showed that participants in the PEERS treatment group experienced significant improvements in social functioning, including teacher-reported gains in social responsiveness, motivation, awareness, and communication. Additionally, participants demonstrated a trend toward improved social cognition on the Social Responsiveness Scale. Adolescent self-reports also indicated significant improvement in social skills knowledge and an increased frequency of get-togethers with friends. Of note, in this study the intervention was implemented by classroom teachers and teacher aides. This is an important consideration in terms of feasibility of implementing an intervention in the school system. Namely, the intervention leaders and whether the school district has identified resources for implementing social skills interventions (i.e., does the school curriculum allow for teachers to implement a social skills intervention). While classroom teachers and aides, school social workers, special education teachers, and school psychologists may have some time allocated to implementing group interventions, another potential consideration is the utilization of trainees in the school system. Group interventions are an excellent learning opportunity for social worker, special education, and school psychology graduate students and undergraduate student teachers may be able to serve as co-leaders of an intervention, especially given the highly manualized nature of many social skills interventions.

Psychosocial Interventions: Anxiety

As previously mentioned, the literature is somewhat inconsistent in terms of prevalence rates of anxiety and subtypes of anxiety for individuals with TS. Thus, more research is necessary before we can understand which anxiety-specific interventions might be useful in the school setting for this population. Furthermore, there is somewhat less research on school based interventions focused on anxiety treatment. However, here we present one school-based

Author Manuscript

intervention that focuses on both social anxiety and social skills called the Skills for Social and Academic Success (SASS; Masia Warner et al., 2018) program as an interesting consideration. It is important to note that social skills and social anxiety are separate constructs. However, the use of interventions that focus on both social skills and exposure to social situations can be an effective treatment modality for social anxiety (Beidel et al., 2014).

SASS is a 12-week school-based cognitive-behavioral group intervention for social anxiety and social skills. In a study conducted by Masia Warner and colleagues (2016), 138 high school students were randomized to one of three conditions: 1) SASS delivered by school counselors (C-SASS), 2) SASS delivered by psychologists (P-SASS), or 3) a control condition in which participants completed Skills for Life (SFL), a non-specific counseling program. Findings showed that adolescents who completed SASS experienced significant reductions in anxiety symptoms at the end of treatment and follow-up. Importantly, the results revealed no significant differences in outcomes between participants who received SASS delivered by school counselors and those who received it from psychologists. This has important implications for the feasibility of utilizing existing school staff to implement group treatments which can increase access to care for a greater number of students.

The Turner Syndrome School Support Plan

School systems often implement small group or targeted social-emotional interventions that individuals with TS would likely benefit from. However, girls with TS may often "fly under the radar" in school due to staff potentially being unfamiliar with TS and its associated psychosocial and educational implications. Additionally, parents and clinical providers may lack awareness of available school support services. One way to increase awareness and increase access to school-based interventions is through implementation of a support plan. The TS school

Author Manuscript

support plan was first introduced in the most recent *Clinical Practice Guidelines for the Care of Girls and Women with Turner Syndrome* (Gravholt et al., 2024). Specifically, recommendation 8.4 Neurocognition, mental health, and well-being (p. G111-G120) called for a "support plan to be prepared by the patient's specialist providers as a tool to empower individuals and their caregivers in advocating for supports, outside the medical environment (e.g., schools, community)," with the goal of optimizing educational and socioemotional development. Individualized health care plans are often utilized in the school system for students with chronic health conditions like diabetes or epilepsy. The guidelines suggest an adapted plan with increased emphasis on psychosocial support for students with TS. It is noted that this support plan should be prepared in a collaborative manner with the individual with TS, their family, their healthcare/specialist provider, and relevant school staff. The support plan (Figures 1 and 2; see Supplementary Materials for downloadable booklet) includes psychoeducation about TS to educate school staff about the primary features and relevant implications often associated with TS. Then, the plan provides space to outline the student's needs as related to both medical and psychosocial care. For example, the support plan might include information about social skills deficits specific to the patient and, in collaboration with the school, the family and providers might identify an existing social skills intervention (e.g., PEERS, SASS, a "lunch bunch" or friendship group) that this student might benefit from joining. Alternatively, the support plan might identify deficits in processing speed for an individual with TS and serve as a guide to implement relevant accommodations, such as providing extra time for tests and breaking down instructions into clear, manageable steps. This support plan is meant to act as a means for increasing awareness and education surrounding how to best support students with TS in the school system and is meant to act as a flexible guide for facilitating communication between

multiple systems (i.e., home, school, medical system) to increase care coordination for individuals with TS and mitigate barriers to psychosocial treatment. However, it is important to note that this support plan was developed recently, and research does not yet exist regarding acceptability or feasibility of the support plan in practice. Future efforts should involve collaboration between healthcare providers, TS specialists, school staff, and individuals with TS and their families to assess the feasibility of the support plan in real-world settings. Additionally, it should explore necessary adaptations to better support students with TS. Furthermore, it is important to note that some individuals with TS may qualify for a 504 plan or an Individualized Education Program (IEP). In such cases, the support plan can serve as psychoeducation for school staff and also act as an informal document to facilitate regular communication between medical, school, and family systems. In circumstances where a student with TS does not qualify for an IEP because they do not meet educational eligibility, the support plan can still be beneficial. It helps ensure that students experiencing social skills deficits or social anxiety—even if these symptoms do not directly impair academic functioning—have access to existing social-emotional support at school.

Barriers and Facilitators to Implementation

Although school based implementation of evidence-based interventions has the potential to increase access to services for children and adolescents, it is essential to consider that schools are also limited by resources in terms of staff, training, time, and financial support. Silveira-Zaldivar and Curtis (2019) conducted a survey study to examine barriers to school implementation of social skills interventions. Themes in survey responses included lack of training in evidence based practices, lack of staff, lack of materials, demands on the school day and prioritization of needs (e.g., emphasis on academics), lack of time to implement

Author Manuscript

Author Manuscript

interventions, cost of implementation, and administrative support. Specifically, one participant (i.e., teacher) in this study shared, “I think principals are starting to realize how much of their time now is being spent on behaviours - time and energy… going into kindergarten, 1st and 2nd grade students with challenging behaviours...” and another teacher stated, “If it's (social skills’ training) going to be utilized in a school, it's really necessary to get the principal to buy-in to the social skill training and, you know, previously their focus has been on test scores, and the focus has been more academic.” These quotes highlight essential considerations for the successful implementation and sustainment of psychosocial interventions in schools. Furthermore, parents of children with TS express a similar sentiment. In Wolstencroft’s (2020) qualitative study, one parent of an individual with TS reported “All the medical things, you can do your best and do tests and it is what it is. But the social skills thing; that’s the thing that really impacts on their daily life the most” (p. 49). As a field, it is important that we engage in participatory action research with educators and school systems to obtain stakeholder input regarding the barriers to implementation and how those barriers can be problem solved. On a broader, macrosystem, level, top-down changes must be prioritized. That is, not only will it be essential for school district administrators to be involved in and have buy-in for the implementation of these interventions, clinicians and researchers must consider how to advocate for policy changes that support increased financial and material support for curriculums that include emphasis not only academics but on psychosocial outcomes as well. This might include researching the importance of social-emotional supports on outcomes for students and then advocating for integrating these supports in educational system. Additionally, systems level change may include contributing to curriculum development for future teachers and special educators that include training on evidence based practices for children with behavioral, emotional, and social differences.

Author Manuscript

While a number of barriers to implementing psychosocial evidence based interventions in the school system, there are also facilitators that help make implementation possible within this system. For instance, many school districts (in the United States) use a Multi-Tiered System of Supports (MTSS) framework. MTSS is a prevention framework that supports the implementation of both academic and behavioral evidence based practices to support student outcomes (see Averill et al., 2011; Eagle et al., 2015; Weingarten et al., 2020 for more details). This framework encourages schools to use screening, progress monitoring, multi-level prevention system, and data-based decision making. There are three tiers within the prevention system: Tier 1 or Universal Instruction includes support that is available for the majority (80-90%) of students. Oftentimes, these supports are delivered to all students by classroom teachers. Tier 2 or Targeted Interventions are aimed at small groups of students with more specific needs (10-20%) and Tier 3 or Intensive Interventions are individual interventions for students with significant needs (less than 10% of students). The interventions outlined in this paper likely fit within universal/Tier 1 (classroom based curriculum) or targeted/Tier 2 (small groups) settings. Incorporating an emphasis on preventative supports for students struggling with social anxiety or social interactions can help students with TS to receive supports earlier which may mitigate more severe challenges and need for intensive treatment later in life. In fact, in a mixed-methods study conducted by Carl and colleagues (2024), one parent of a teen with TS stated “I didn’t know that [anxiety] could be an issue at the beginning. So, I know it was quite a while ago, so I don’t know if [TS doctors] really knew that much about anxiety. ... I didn’t have any idea about the anxiety until we’d already kind of figured out that’s what that was. Might have been nice if, looking back now, if I had that information” (p. 11).

Conclusion and Future Directions

Author Manuscript

The neurocognitive profile of TS has been well-defined and research on psychosocial considerations continues to emerge. It is essential to consider what clinicians can do with these descriptive findings. Some research indicates that while youths with TS and their parents report feeling well supported by their medical teams in terms of medical surveillance, there is room for improvement in terms of the medical team discussing psychosocial components that can be associated with TS.

This paper provides an overview of the relevant psychosocial considerations associated with TS. However, it is essential to note that this paper serves as a brief and non-comprehensive introduction to psychosocial interventions for individuals with TS. Our hope is that the reader is left considering how their own practices may incorporate collaboration with school teams to increase quality coordinated care for patients. We encourage providers, such as genetic counselors, to consider how to utilize this information to improve the quality of comprehensive care for patients in their practice. Readers of this review paper are encouraged to collaborate with the psychologist at their TS clinic, if available. Additionally, providers might consider using the TS support plan presented in this paper (see Supplementary Materials for Support Plan Booklet) with interested caregivers and patients. It is hoped that future research will examine the effectiveness and acceptability of collaboration between medical and school teams through the use of this support plan. Specifically, next steps may include conducting a needs assessment and engaging in participatory action research. Using the Exploration, Preparation Implementation, Sustainment (EPIS) implementation framework (Aarons et al., 2011), we identify that we are relatively early in the exploration phase. Future research may include working with relevant stakeholders (e.g., teachers, school administrators, individuals with TS, parents of children with TS, medical providers) to conduct focus groups and consider barriers and facilitators to

implementation of the Support Plan to obtain more detailed feedback prior to preparation, implementation, and sustainment of interventions.

Author Manuscript

Author Manuscript

Figure 1

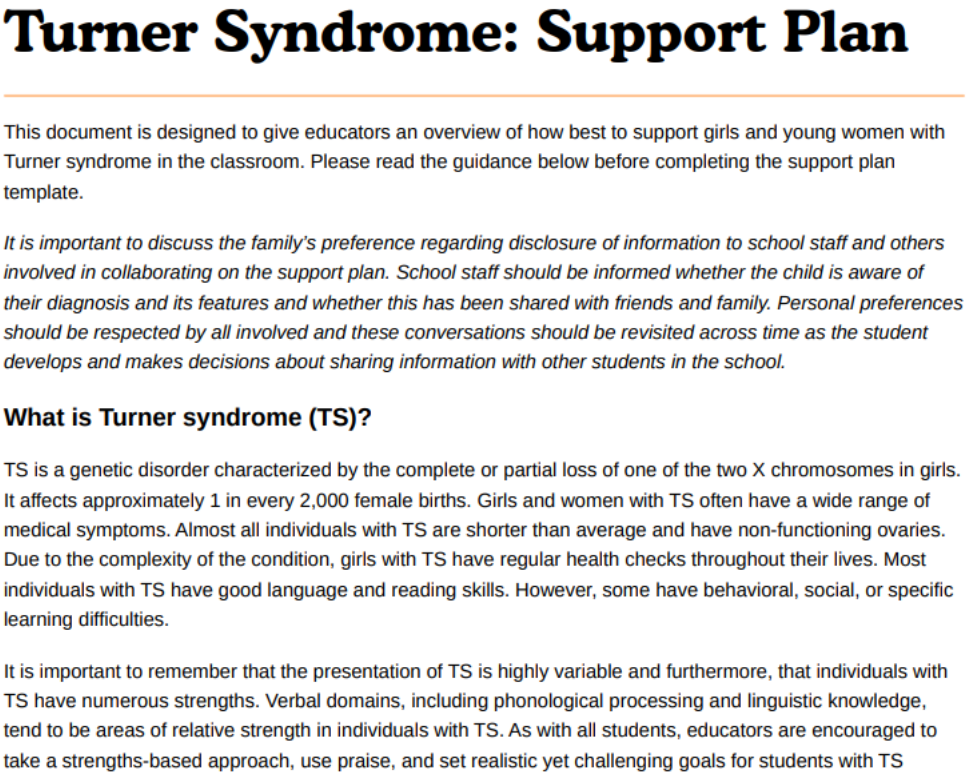
Figure Excerpt from the Turner Syndrome Support Plan



Note. See the Supplementary Materials for downloadable and fillable booklet.

Figure 2

Figure Excerpt from page 1 of the Turner Syndrome Support Plan



Turner Syndrome: Support Plan

This document is designed to give educators an overview of how best to support girls and young women with Turner syndrome in the classroom. Please read the guidance below before completing the support plan template.

It is important to discuss the family's preference regarding disclosure of information to school staff and others involved in collaborating on the support plan. School staff should be informed whether the child is aware of their diagnosis and its features and whether this has been shared with friends and family. Personal preferences should be respected by all involved and these conversations should be revisited across time as the student develops and makes decisions about sharing information with other students in the school.

What is Turner syndrome (TS)?

TS is a genetic disorder characterized by the complete or partial loss of one of the two X chromosomes in girls. It affects approximately 1 in every 2,000 female births. Girls and women with TS often have a wide range of medical symptoms. Almost all individuals with TS are shorter than average and have non-functioning ovaries. Due to the complexity of the condition, girls with TS have regular health checks throughout their lives. Most individuals with TS have good language and reading skills. However, some have behavioral, social, or specific learning difficulties.

It is important to remember that the presentation of TS is highly variable and furthermore, that individuals with TS have numerous strengths. Verbal domains, including phonological processing and linguistic knowledge, tend to be areas of relative strength in individuals with TS. As with all students, educators are encouraged to take a strengths-based approach, use praise, and set realistic yet challenging goals for students with TS

Note. See the Supplementary Materials for downloadable and fillable booklet.

Author Manuscript

Author Manuscript

References

Aarons, G. A., Hurlburt, M., & Horwitz, S. M. (2011). Advancing a conceptual model of evidence-based practice implementation in public service sectors. *Administration and policy in mental health*, *38*(1), 4–23. https://doi.org/10.1007/s10488-010-0327-7

Averill, O. H., Rinaldi, C., & Collaborative, U. S. E. L. (2011). Multi-tier system of supports (MTSS). *District Administration, 48(8),* 91-95.

Beidel, D. C., Alfano, C. A., Kofler, M. J., Rao, P. A., Scharfstein, L., Wong Sarver, N. (2014). The impact of social skills training for social anxiety disorder: A randomized controlled trial. *Journal of Anxiety Disorders, 28*, 908-918.

Bispo, A. V. S., Buergio-Frota, P., Oliveira dos Santos, L., Leal, G. F., Duarte, A. R., Araujo, J., Cavalcante da Silva, V., Muniz, M. T. C., Liehr, T., & Santons, N. (2013). Y chromosome in Turner syndrome: Detection of hidden mosaicism and the report of a rare X;Y translocation case. *Reproduction, Fertility and Development, 26,* 1176-1182.

Björlin Avdic, H., Butwicka, A., Nordenström, A., Almqvist, C., Nordenskjöld, A., Engberg, H., & Frisén, L. (2021). Neurodevelopmental and psychiatric disorders in females with Turner syndrome: a population-based study. *Journal of neurodevelopmental disorders*, *13*, 1-9.

Burstein, M., He, J. P., Kattan, G., Albano, A. M., Avenevoli, S., & Merikangas, K. R. (2011). Social phobia and subtypes in the National Comorbidity Survey–Adolescent Supplement: prevalence, correlates, and comorbidity. *Journal of the American Academy of Child & Adolescent Psychiatry*, *50*(9), 870-880.

Author Manuscript

Cardoso, G., Daly, R., Haq, N. A., Hanton, L., Rubinow, D. R.,Bondy, C. A., & Schmidt, P. (2004). Current and lifetime psychiat-ric illness in women with Turner syndrome. *Gynecological Endocrinology, 19(6),* 313–319.

Carl, A., Good, M., Haag, E., Hutaff-Lee, C., Swain, D., Tartaglia, N., Sakamoto, C., Davis, S., & Thompson, T. (2024). Anxiety in Turner syndrome: Engaging community to address barriers and facilitators to diagnosis and care. *American Journal of Medical Genetics Part A*, e63564.

Eagle, J. W., Dowd-Eagle, S. E., Snyder, A., & Holtzman, E. G. (2015). Implementing a multi-tiered system of support (MTSS): Collaboration between school psychologists and administrators to promote systems-level change. *Journal of Educational and Psychological Consultation*, *25*(2-3), 160-177

Gravholt, C. H., Andersen, N. H., Christin-Maitre, S., Davis, S. M., Duijnhouwer, A., Gawlik, A., ... & Backeljauw, P. F. (2024). Clinical practice guidelines for the care of girls and women with Turner syndrome: Proceedings from the 2023 Aarhus International Turner Syndrome Meeting. *European Journal of Endocrinology*, *190*(6), G53-G151.

Green, T., Naylor, P. E., & Davies, W. (2017). Attention deficit hyperactivity disorder (ADHD) in phenotypically similar neurogenetic conditions: Turner syndrome and the RASopathies. *Journal of Neurodevelopmental Disorders*, *9*, 1-12.

Hong, D. S., Dunkin, B., & Reiss, A. L. (2011). Psychosocial functioning and social cognitive processing in girls with Turner syndrome. *Journal of Developmental and Behavioral Pediatrics*, *32*(7), 512–520. https://doi.org/10.1097/DBP.0b013e3182255301

Hong, D. S., & Reiss, A. L. (2014). Cognitive and neurological aspects of sex chromosome aneuploidies. *The Lancet Neurology, 13,* 306-318.

Author Manuscript

Kiliç, B. G., Ergür, A. T., & Öcal, G. (2005). Depression, levels of anxiety and self-concept in girls with Turner's syndrome. *Journal of Pediatric Endocrinology and Metabolism*, *18*(11), 1111-1118.

Kremen, J., Davis, S. M., Nahata, L., Kapa, H. M., Dattilo, T. M., Liu, E., Hutaff-Lee, C., Tishelman, A. C., & Crerand, C. E. (2023). Neuropsychological and mental health concerns in a multicenter clinical sample of youth with turner syndrome. *American Journal of Medical Genetics,191(4),* 962–976.

Kuntsi, J., Skuse, D., Elgar, K., Morris, E., & Turner, C. (2000). Ring-X chromosomes: Their cognitive and behavioural phenotype. *Annals of Human Genetics, 64,* 295-305.

Lagrou, K., Xhrouet-Heinrichs, D., Heinrichs, C., Craen, M., Chanoine, J.-P., Malvaux, P., & Bourguignon, J.-P. (1998). Age-related perception of stature, acceptance of therapy, and psychosocial functioning in human growth hormone-treated girls with Turner's Syndrome. *The Journal of Clinical Endocrinology & Metabolism, 83(5)*, 1494–1501.

Laugeson, E. A., & Frankel, F. (2011). *Social skills for teenagers with developmental and autism spectrum disorders: The PEERS treatment manual*. Routledge.

Laugeson, E. A., Ellingsen, R., Sanderson, J., Tucci, L., & Bates, S. (2014). The ABC's of teaching social skills to adolescents with autism spectrum disorder in the classroom: The UCLA PEERS® program. *Journal of autism and developmental disorders*, *44*, 2244-2256.

Masia Warner, C., Colognori, D., & Lynch, C. (2018). *Helping students overcome social anxiety: Skills for academic and social success (SASS)*. Guilford Publications.

Masia Warner, C., Colognori, D., Brice, C., Herzig, K., Mufson, L., Lynch, C., Reiss, P. T., Petkova, E., Fox., J., Moceri, D. C., Ryan, J. & Klein, R. G. (2016). Can school

Author Manuscript

counselors deliver cognitive-behavioral treatment for social anxiety effectively? A randomized controlled trial. *Journal of Child Psychology and Psychiatry*, *57*(11), 1229-1238.

Masia Warner, C., Fisher, P. H., Shrout, P. E., Rathor, S., & Klein, R. G. (2007). Treating adolescents with social anxiety disorder in school: An attention control trial. *Journal of Child Psychology and Psychiatry*, *48*(7), 676-686.

McCauley, E., Feuillan, P., Kushner, H., & Ross, J. L. (2001). Psychosocial development in adolescents with Turner syndrome. *Journal of Developmental & Behavioral Pediatrics*, *22*(6), 360-365.

Messina, M. F., Zirilli, G., Civa, R., Rulli, I., Salzano, G., Versa, T. A., & Valenzise, M. (2007). Neurocognitive profile in Turner's syndrome is not affected by growth impairment. *Journal of Pediatric Endocrinology and Metabolism*, *20*(6), 677-684.

Mazzocco, M. M. (2009). Mathematical learning disability in girls with Turner syndrome: a challenge to defining MLD and its subtypes. Dev Disabil Res Rev, 15(1), 35-44.

Pennington, B., Heaton, R., Karzmark, P., Pendleton, M. G., Lehman, R., & Shucard, D. W. (1985). The neuropsychological phenotype in Turner syndrome. Cortex, 21, 391-404.

Pretzel, R. E., Knickmeyer, R. C., DeRamus, M., Duquette, P., Okoniewski, K. C., Reinhartsen, D. B., ... & Hooper, S. R. (2020). Early development of infants with Turner syndrome. *Journal of Developmental & Behavioral Pediatrics*, *41*(6), 470-479.

Reichow, B., & Volkmar, F. R. (2010). Social skills interventions for individuals with autism: Evaluation for evidence-based practices within a best evidence synthesis framework. *Journal of autism and developmental disorders*, *40*, 149-166.

Author Manuscript

Reinhartsen, D. B., Cornea, E., DeRamus, M., Waitt, A. B., Pretzel, R. E., Knickmeyer, R. C., ... & Hooper, S. R. (2021). Turner syndrome: language profile of young girls at 12 and 24 months of age. *Journal of Neurodevelopmental Disorders*, *13*, 1-13.

Ross, J. L., Roeltgen, D., Kushner, H., Wei, F., & Zinn, A. R. (2000). The Turner syndrome–associated neurocognitive phenotype maps to distal Xp. *The American Journal of Human Genetics*, *67*(3), 672-681.

Russell, H. F., Wallis, D., Mazzocco, M. M., Moshang, T., Zackai, E., Zinn, A. R., ... & Muenke, M. (2006). Increased prevalence of ADHD in Turner syndrome with no evidence of imprinting effects. *Journal of pediatric psychology*, *31*(9), 945-955.

Ryan, J. L., & Masia Warner, C. (2012). Treating adolescents with social anxiety disorder in schools. *Child and adolescent psychiatric clinics of North America*, *21*(1), 105–ix. https://doi.org/10.1016/j.chc.2011.08.011

Sandberg, D. E., Singer, D., Bugajski, B., Gebremariam, A., Scerbak, T., Dooley Maley, K. L., ... & Silberbach, M. (2019, March). Research priorities of people living with Turner syndrome. In *American Journal of Medical Genetics Part C: Seminars in Medical Genetics* (Vol. 181, No. 1, pp. 13-21). Hoboken, USA: John Wiley & Sons, Inc.

Suzigan, L. Z., De Paiva e Silva, R. B., Guerra-Junior, G., Marini, S. H. V. L., & Maciel-Guerra, A. T. (2011). Social skills in women with Turner Syndrome. *Scandinavian Journal of Psychology, 52(5)*, 440–447. https://doi.org/10.1111/j.1467-9450.2011.00887.x

Viuff, M., Skakkebæk, A., Nielsen, M. M., Chang, S., & Gravholt, C. H. (2019, March). Epigenetics and genomics in Turner syndrome. In *American Journal of Medical Genetics Part C: Seminars in Medical Genetics* (Vol. 181, No. 1, pp. 125-132). Hoboken, USA: John Wiley & Sons, Inc.

Author Manuscript

Weingarten, Z., Zumeta Edmonds, R., & Arden, S. (2020). Better together: Using MTSS as a structure for building school–family partnerships. *Teaching Exceptional Children*, *53*(2), 122-130.

Wolstencroft, J. S. C. (2019). Mental health and neurodevelopmental disorders in Turner Syndrome: New approaches to psycho-social management. [Doctoral thesis, University College London]. UCL Discovery. https://discovery.ucl.ac.uk/id/eprint/10088458/

Wolstencroft, J., Kerry, E., Denyer, H., Watkins, A., Mandy, W., & Skuse, D. (2021). New approaches to social skills training: Blended group interventions for girls with social communication difficulties. *Autism Research*, *14*(5), 1061-1072.

Wolstencroft, J., Mandy, W., & Skuse, D. (2020). Experiences of social interaction in young women with Turner syndrome: A qualitative study. *Child: Care, Health and Development*, *46*(1), 46-55.

Wolstencroft, J., Mandy, W., & Skuse, D. (2022). Mental health and neurodevelopment in children and adolescents with Turner syndrome. *Women's Health*, *18*, 17455057221133635

Wolstencroft, J., & Skuse, D. (2019). Social skills and relationships in Turner syndrome. *Current Opinion in Psychiatry*, *32*(2), 85-91.

Yoo, H. J., Bahn, G., Cho, I. H., Kim, E. K., Kim, J. H., Min, J. W., ... & Laugeson, E. A. (2014). A Randomized Controlled Trial of the K orean Version of the PEERS® Parent-Assisted Social Skills Training Program for Teens With ASD. *Autism Research*, *7*(1), 145-161.

Zuniga, R. M. (2019). Instructional strategies to support and accommodate the learning, social/emotional, and health needs of female students with Turner Syndrome in

elementary and secondary school. [Master's Thesis, California State University San Marcos]. https://scholarworks.calstate.edu/downloads/v405sg248

Author Manuscript