



FASD Screening Tool Development Project

FASD Screening in Children and Youth

A REVIEW OF THE LITERATURE



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Table of Contents

1. Project Overview	1
2. Screening for FASD	1
2.1 Background	1
2.2 Why screen for FASD?	2
2.3 Screening Mothers Antenatally/Postnatally.....	2
3. Review Search Methods.....	3
4. Physical Screening Tools.....	3
4.1 Facial phenotype	3
4.2 Screening Checklist	4
5. Neuroimaging	5
5.1 Ultrasound	5
5.2 Electroencephalography (EEG)	5
5.3 Magnetic Resonance Imaging (MRI).....	5
5.4 Diffusion Tensor Imaging (DTI).....	6
6. Biomarkers	6
6.1 Meconium.....	6
6.2 Hair.....	6
6.3 Cord Blood	7
7. Psychological/Neurobehavioural/Neurophysiological.....	7
8. Justice System.....	9
9. Diagnostic Capacity	10
10. Conclusion.....	10
11. References	12

1. Project Overview

On March 1, 2005 the Public Health Agency of Canada endorsed the Canadian Guidelines for the diagnosis of Fetal Alcohol Spectrum Disorder (FASD)¹. The capacity of diagnostic clinics, however, is low compared to the prevalence of FASD. The validity and reliability of available screening tools has not yet been verified, limiting the ability of health care and allied professionals across Canada to consistently screen for FASD and refer for further assessment and diagnosis.

In partnership with many FASD experts and organizations, the Canadian Association of Paediatric Health Centres (CAPHC) is currently facilitating a national initiative, funded by the Public Health Agency of Canada, entitled: “Developing a National Screening Tool Kit for Those Identified and Potentially Affected by FASD”. Drs. Albert Chudley, Sterling Clarren, Gideon Koren, and Ted Rosales are the content experts leading the Project’s Steering Committee.

The primary objectives of this initiative are to:

- Survey and critically evaluate FASD screening tools and methods in use in Canada for referral to, or acceptance into, diagnostic clinics;
- Evaluate practical values (sensitivity, specificity, and predictive values) of these tools; and
- Develop practical guidelines (Tool Kit), based on the identified and evaluated tools.

This review of literature has been conducted to critically evaluate the research related to FASD screening tools and methods for children and youth, and to provide insight and direction to the Steering Committee regarding appropriate tools for consideration.

A National Advisory Group of experts has participated in a workshop to further evaluate screening tools and methods currently in use in Canada and the United States. A second workshop was held of frontline providers who evaluated the screening tools for their practical application. Proceedings of these workshops can be found on the CAPHC website: http://www.caphc.org/programs_fasd.html.

2. Screening for FASD

2.1 Background

Maternal alcohol consumption during pregnancy adversely affects the fetus and can result in Fetal Alcohol Spectrum Disorders (FASD). FASD ranges in presentation from fetal alcohol syndrome (FAS) to other alcohol-related disabilities including alcohol-related neurodevelopmental disorders (ARND) and fetal alcohol effects (FAE). FASD encapsulates individuals affected with behavioural changes with and/or without the presence of physical changes^{2,3}. FAS is characterized by facial dysmorphism including a smooth philtrum, thin upper lip, and small eyes⁴. ARND include deficits in basic cognitive functioning, social emotional, and behavioural difficulties³. Those affected by FASD may have difficulties in planning, organization, and attention; failure to learn from consequences; memory deficit; speech/language visuospatial functioning; spatial memory; and deficits in verbal learning⁵⁻¹⁰.

2.2 Why screen for FASD?

Prenatal alcohol exposure is one of the leading causes of mental retardation in the western world¹¹. FASD is estimated to affect 9.1/1,000 live births¹². The prevalence of FASD in the United States has been reported as 0.5–2/1,000 live births¹³. The prevalence of FASD in South Africa has been reported as 39.2–46.4/1,000 births¹⁴. To date, there is no available estimate of the prevalence of FASD for the Canadian population. Due to the high estimated prevalence rates observed in other countries it is important to ascertain the prevalence of FASD in Canada.

There is a high cost associated with FASD¹⁵⁻¹⁷. Abel et al. estimated that the annual cost of FASD to the healthcare system was \$74.6 million US¹⁵. Harwood et al. estimated societal costs of FASD to be as high as \$9.69 billion US¹⁶. A cross-sectional survey by Stade et al. reported that the total adjusted annual expenditure per FASD person aged 1–21 years was \$14,342 (95%CI \$12,986–\$15,698)¹⁷. The average cost of FASD annually was \$344,208,000 (95%CI \$311,664,000–\$376,752,000)¹⁷.

Previous studies have suggested that earlier intervention in FASD affected individuals will decrease the risk of developing secondary disabilities¹⁸. As such the potential economic costs may decrease with earlier identification of these individuals. Thus it is important to develop a screening program that will enable individuals to be referred to diagnostic centres to receive full evaluation. In doing so, those who are diagnosed with a FASD condition can receive the necessary support or interventions required.

There is currently no standardized screening tool for FASD. This is most likely because there is no single biological marker that will quickly identify the problem compared with genetic conditions which have a single specific biomarker. Moreover, the cognitive and behavioural effects associated with FASD are not specific to prenatal alcohol exposure alone. Since FASD affects persons accessing multiple systems it is important that professionals in frontline settings including, healthcare workers, family physicians, nurses, pediatricians, psychiatrists, teachers, administrators, school psychologists, special education consultants, and youth justice personnel, including judges, probation officers, and corrections officers, actively screen for these individuals.

2.3 Screening Mothers Antenatally/Postnatally

Asking mothers about their alcohol consumption during pregnancy is one method of screening for prenatal alcohol exposure. Ideally, if the mother answers truthfully, this screening method would be both sensitive and specific. However, this is not always the case. Mothers may provide an incorrect assessment of alcohol use due to reasons including recall bias, fear of losing their child, embarrassment, and fear of stigma^{19,20}. Another method of screening is to identify mothers who have a known history of substance abuse. Since screening of biological mothers is not always accurate or an available option, other tools for screening must also be explored. This review will focus on methods used to screen for FASD in children and youth.

3. Review Search Methods

A search of the existing literature regarding screening for fetal alcohol spectrum disorders was undertaken. All original articles reporting on different methodologies of screening for fetal alcohol spectrum disorders in children (≤ 18 years) were included. Articles reporting on screening in adults were excluded. Search terms included screening, fetal alcohol spectrum disorder, fetal alcohol syndrome. Medline (1966, December 31, 2007 and PubMed (December 31, 2007) were searched in all languages. References of retrieved articles were reviewed to identify additional articles of interest. The following terms were used to evaluate the effectiveness of the screening tools and methods: sensitivity (the proportion of true positives), specificity (the proportion of true negatives), and positive predictive value (PPV) (the proportion of positive test results that are correctly diagnosed).

4. Physical Screening Tools

4.1 Facial phenotype

FAS is characterized by facial dysmorphia: small palpebral fissures, smooth philtrum and thin upper lip⁴. Astley *et al.* derived a quantitative case definition of the FAS facial phenotype by evaluating children 0–10 years of age between January 1993–January 1995²¹. They demonstrated that hypoplastic midface, smooth philtrum and thin upper lip are best differentiated in children with and without FAS²¹. D-scores were 100% sensitive, 87.2% specific (3-point Likert scale)²¹. From their facial studies, Astley *et al.* developed a photographic screening tool for the FAS facial phenotype²². This tool employs the 4-digit diagnostic code (growth deficiency, FAS face phenotype, central nervous system (CNS) damage/dysfunction, and gestational alcohol exposure²³ and D-score to measure the magnitude of expression of FAS facial phenotype²². To evaluate this screening tool, they recruited 42 subjects with FAS and compared them to 84 controls without FAS²². Photographs were obtained aligned to the frontal plane and phenotypic expressions were recorded on a 5-point Likert scale²². Facial measurements had 99% sensitivity, 95% specificity, and 98% accuracy²². Sensitivity and specificity were not affected by race, gender, and age²².

Using the facial screening tool in the foster care population of the Region 4 Foster Care Passport Program, they screened children age 0–12 years between March 1999–September 2001²⁴. Facial features were ranked using the Lip-Philtrum Guide in their Fetal Alcohol Syndrome Facial Photographic Analysis Software (Version 1.0.0.)^{22,25}. The prevalence of FAS in this population was 10/1,000²⁴. The screening tool performed with 100% sensitivity, 99.8% specificity, 85.7% predictive value positive, and 100% predictive value negative²⁴. Astley *et al.* proposed that the face not only could be a screening tool but a method of diagnosing FAS since craniofacial anthropometry coupled with multivariate analysis can identify individuals with FAS^{23,26,27}.

Avner *et al.* validated the facial photographic method proposed by Astley *et al.* using their software²⁸. A study of 40 children resulted in four false positive cases and no false negative cases —100% sensitivity, 64% specificity²⁸. They observed that the computer-assisted measurement tended to underestimate the true length of the palpebral fissure, especially in children under four years old²⁸. As such, this method may serve as a useful FAS screening tool since it will identify more individuals rather than miss children potentially affected with FAS²⁸.

To examine ethnic differences, a study of South African students was conducted to assess the suitability of the reference values for facial phenotype²⁹. Facial measurements: palpebral fissure length (PFL), interpupillary distance (IPD), inner canthal distance (ICD) and outer canthal distance (OCD) were obtained in a group of black South African boys (n=17) and girls (n=17) of 7 years of age²⁹. Eye distance measurements in the study did not reflect published measurements²⁹. Another study examining unique facial features amongst ethnic populations analysed facial differences between Cape Coloured, Finnish Caucasian, African American, and North American Caucasian³⁰. Reduced size of the eye orbit was a consistent feature discriminating FAS³⁰. However, each population had unique, overlapping variables — demonstrating that ethnic differences in the presentation of FAS do exist³⁰. Another facial landmark study observed that adding mid-face hypoplasia with palpebral fissure length, upper lip thickness, and philtrum smoothness was able to reveal differences between FAS and normal subjects of subjects of different ethnic variations³¹.

The advantages of using facial phenotype screening are that it is standardized, objective, reproducible, and can diagnosis with the presence of CNS dysfunction/facial anomaly. It is also an inexpensive screen that does not require professional expertise during photograph collection. Photographs can be cropped if needed and transferred to a centralized facility for interpretation.

The disadvantages are that the photographs must be taken correctly: the camera must be aligned horizontally, and facial expression must have eyes opened and lips gently closed. Another disadvantage is that it will only screen for FAS, therefore persons affected with FASD (not exhibiting the facial features) will screen negative³². It is also important to screen at an early age as facial features associated with prenatal alcohol exposure change and become less distinctive as individuals age³³. Ethnic difference may affect the expression of facial phenotype²⁹. Normative ranges for all ethnicities have not yet been determined. Moreover, it may be difficult to derive normal values for interracial children.

4.2 Screening Checklist

Burd *et al.* published a checklist they use to screen for FAS³⁴. This checklist focuses physical parameters but also addresses developmental changes³⁴. Poitra *et al.* published their experience using this 32-item FAS screening test in kindergarten students³⁵. Burd *et al.* reported in the normal sample this screening tool had a 100% sensitivity, 94% sensitivity, with a positive predictive value of 92% and accuracy of 94%³⁴. Staff received 4 hours of training on the screening tool and a 10-minute screening was conducted by the school after obtaining consent³⁵. 1,384 students were screened over a 9-year period during which time 69 (5%) screened positive³⁵. After referral to diagnostic centres for diagnosis, 7 (10%) were found to have FAS or partial FAS³⁵. The screening tool was 100% sensitive, 95.43% specific, and 95% accurate³⁵. As such it is efficient for community-based screenings. The advantage to this screening method is that it is a low cost screening program that schools should be able to complete without additional financial, logistical, or technical support that screens for FASD. The disadvantages are that no neurobehavioural considerations are considered in this screening method and that skill and judgment are required to assess dysmorphic features may be beyond the scope and comfort level of many frontline providers.

5. Neuroimaging

5.1 Ultrasound

Although studies have demonstrated that ultrasound screening for small for gestation age have demonstrated 80–90% sensitivity³⁶ intrauterine growth restriction has a low specificity as there are many conditions which may result in intrauterine growth restriction.

A study by Bookstein *et al.* assessed 18 children 5–16 weeks after birth using ultrasound imaging of 50 freeze-frame midsagittal sections³⁶. They observed that the midline corpus callosum of infants exposed prenatally to alcohol exhibited abnormality of the splenium³⁶. Despite the usage of ultrasonography as a non-invasive and relatively inexpensive test, this study was limited by its small sample size and has not been reproduced to demonstrate its validity and reproducibility. Ultrasound also requires a skilled technologist and radiologist to interpret the results.

5.2 Electroencephalography (EEG)

A literature search of studies using EEG techniques found 17 papers in infants exposed to alcohol³⁷. Disturbances in sleep cycles and arousals were apparent depending on trimester of exposure³⁷. Also observed were sensory impairment suggestive of atypical brain maturation and impairments in attention and cognitive functions³⁷. The advantage of EEG testing is that it is noninvasive, generally available and inexpensive, and does not require active response. The disadvantages are that there is a lack of control factors in studies, there is questionable reliability, and there is difficult comparing studies comparing different measures.

5.3 Magnetic Resonance Imaging (MRI)

Magnetic resonance has been used to detect chemical elements e.g. markers of neuronal integrity and cell death. Functional MRI (fMRI) has also been utilized to identify differences. fMRI may help characterize the neural underpinnings of abnormalities. Magnetic resonance spectroscopy (MRS) is used to quantify metabolites in body tissues. MRI studies have demonstrated that persons with FASD have reduction in size of the cranial vault^{10,38-40}, reduced brain size^{10,38-42}, alteration in size and shape of corpus callosum⁴³⁻⁴⁷, displacement of corpus callosum⁴⁸, reduction of basal ganglia size^{38,49}, reduction of cerebellum size⁴⁸, reduction in hippocampus⁴¹, reduction in white matter in cerebrum⁴⁰, altered corpus callosum^{43,50-56}, frontal and parietal lobe anomalies^{42,48}, reduced surface area and volume of cerebellum⁵⁷, altered frontal-striatal response⁵⁸, abnormal cortical thickness⁵⁹, and reduced volume of basal ganglia in prenatal alcohol exposed children⁴⁸. Greater inferior-middle frontal lobe activity was observed in FASD in children and adults⁶⁰. MRS studies demonstrated altered N-acetylaspartate/choline metabolite ratios in persons affected with FASD compared to controls^{61,62}.

The advantage to screening using MRI is that it is a non-invasive test that has no age restriction. The disadvantages, however, include the cost. It is an expensive piece of medical equipment that is not readily available in all areas. This non-portable machine also requires a skilled operator and radiologist for interpretation. Therefore persons in remote communities are unable to obtain easy access. Furthermore MRI has neither been validated as a screening tool nor has specificity and sensitivity been determined. Perhaps MRI may be more effective in the diagnostic process to confirm neurological irregularities.

5.4 Diffusion Tensor Imaging (DTI)

DTI uses the diffusion of water molecules to measure the tissue microstructural integrity that is useful in characterizing white matter⁶³. Diffusion tensor imaging may be useful in studying neurodevelopmental disorders, including FASD, because it is sensitive to abnormalities against the “background” changes of normal development⁶⁴. Microstructural abnormalities have been observed in patients with FAS⁶³. One study used DTI to examine the corpus callosum in adults with FASD and observed lower fractional anisotropy and higher MD were observed in splenium and genu of the corpus callosum in the alcohol-exposed group versus controls⁶⁵. No associations were found between the DTI measures and dysmorphia score, IQ, or processing speed⁶⁵. Another study of 14 children with FASD aged 10–13 years and matched controls exhibited a trend toward smaller total cerebral volume in the FASD group ($p=0.057$)⁶⁶. There was also a greater mean diffusivity observed in the isthmus of the corpus callosum of FASD subjects ($p=0.013$), suggesting micro-structural abnormalities in this region⁶⁶. The advantages and disadvantages of DTI are the same as MRI.

6. Biomarkers

6.1 Meconium

Meconium is the first fecal matter passed by the newborn. Fatty acid ethyl esters (FAEE) are non-oxidative metabolites of ethanol that are formed in the body by esterification of ethanol with free fatty acids. FAEE do not pass the placenta, as such the presence of FAEE in the meconium represents a true estimate of fetal ethanol exposure⁶⁷. Meconium begins forming at approximately 12 weeks of pregnancy. Meconium can be collected up to approximately 72 hours after birth. Commonly quantified FAEE include linoleic, palmitic, oleic, steric, and palmitoleic ethyl esters⁶⁸. Several FASD screening studies have been undertaken by measuring FAEE in meconium. A study screening meconium in a Hawaiian regional birthing center observed a prevalence of 16.7% positive FAEE⁶⁸. An anonymous population study collected meconium from all birthing centres and reported a 2.5% FAEE positive meconium⁶⁹. A study of meconium collected in Montevideo observed a 44% positive FAEE rate⁷⁰. More recently, an anonymous population study of newborns of Grey-Bruce residents who were delivered/transferred to a tertiary healthcare centre measured a 26% positive FAEE⁷¹.

The advantage of meconium screening is that it is an easy non-invasive method of screening of otherwise discarded material. Meconium is heat and light sensitive therefore it should be stored in opaque containers and stored frozen and shipped on ice⁷². The disadvantage of meconium screening is that there is a limited window to collect meconium. Meconium is only able to detect prenatal ethanol exposure in the second and third trimester of pregnancy. Moreover, there has not yet been a correlation of how much FAEE correspond to the development of FASD.

6.2 Hair

FAEE can enter the hair by capillary blood supply, transport via the sebaceous gland, transport via sweat glands, and adsorption via passive exposure. Neonatal hair begins forming at approximately 20 weeks of pregnancy and can be collected up to three months after birth, after which point the neonatal hair typically sheds. Hydrophobic molecules can accumulate in the hair shaft. FAEE have been demonstrated to concentrate in the hair matrix in adults⁷³.

Studies in neonates have demonstrated that babies exposed to alcohol have been able to quantify FAEE in infants exposed to excessive quantities of alcohol^{74,75}. The advantages to this screening method include that hair is easy to collect, it is a non-invasive procedure and there is a longer window for collection. The disadvantages to this screening method include that it is only able to document exposure from 20 weeks of pregnancy. Some cultures also have sensitivities regarding cutting infant hair. This test however is in its developmental stages and its clinical sensitivity and specificity have not yet been determined. Further studies will need to be undertaken before this tool can be used as a screening tool for FASD.

6.3 Cord Blood

In attempt to identify a potential screening tool for FASD Gallot *et al.* measured AST, ALT, GGT, CDT in fetal cord blood to exposed neonates immediately after birth over a 1-year period⁷⁶. Of 870 samples, only 2 cases of FASD were identified and there were no significant correlations between maternal and cord blood biomarkers⁷⁶. Thus, using these parameters is not an effective means of screening for prenatal alcohol exposure.

7. Psychological/Neurobehavioural/Neuro-physiological

Children with prenatal alcohol exposure may present with a complex diagnostic picture and a wide variety of psychological symptoms. Persons affected with FASD have deficits in cognitive and academic functioning, psychological disorders behavioural problems, and difficulties with independent living³. Neuropsychological sequelae including executive functioning difficulties have been observed^{8,77,78}. Social skills deficits including poor social judgment, failure to learn from experience, difficulty understanding consequences of actions, aggression, inappropriate sexual behaviour, delinquency, lack of understanding of social cues, and communicating in social contexts have also been observed^{7,33,79-81}. Hyperactivity and attention problems are some of the most frequently reported symptoms associated with prenatal alcohol exposure and reported in the research literature^{8,82,83}. Individuals with FASD also often demonstrate impulsivity, poor judgment, and great difficulty learning from consequences^{79,84,85}.

Exposure to alcohol in the first and second trimesters has been associated with lower overall academic achievement. Lower reading scores, spatial and verbal memory and learning were associated with second trimester binge drinking as were problems in processing and arithmetic^{84,86,87}. Mattson *et al.* reviewed IQ in many studies with children diagnosed with FAS and found a mean of 65.73 (20–120)⁸⁶. The mean IQ for FASD was 72.26 (47.4–98.2)⁸⁶. They concluded that high levels of prenatal alcohol exposure are related to increased deficits in intellectual functioning⁸⁶.

There is limited literature regarding using psychological evaluations to screen for FASD. The majority of literature reports on psychological testing as a process used in of FASD diagnoses. These testing

* <http://depts.washington.edu/fasdpn/htmls/photo-face.htm>

methods include the use of Bayley Scales, Wechsler Intelligence Scale for Children (WISC-III), Griffiths Mental Developmental Scales, Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R), Fagan Test of Infant Intelligence, Children's Memory Scale (CMS), Behavioral Rating Inventory of Executive Function (BRIEF), Parent and Teachers Conners' Ratings Scales-Revised (CRS-R), and Child Behavioral Checklist (CBCL)^{10,88-93}.

Streissguth *et al.* set out to develop a scale that would describe the behaviours of FASD⁹⁴. They assembled a list of 68 short descriptors "Personal Behaviors Checklist" that were answered by someone familiar with the child's behavior and condensed the checklist into 36-item scale called the Fetal Alcohol Behavior Scale (FABS)⁹⁴. A screening study was conducted to evaluate its ability to detect persons affected with FASD and a normative study to evaluate the sensitivity of the test in children⁹⁴. 186 caregivers completed the 5 minute questionnaire for their children⁹⁴. The Cronbach's coefficient was 0.89, indicating high reliability⁹⁴. FABS scores appear to be correlated with maternal alcohol problems and reflect the behavioral phenotype of fetal alcohol fairly specifically rather than being raised in an alcoholic environment⁹⁴. Further studies are needed to clarify its utility in a diagnosis or screening context. Instruments like the FABS should not be used clinically for diagnosis without additional evidence of prenatal alcohol exposure.

Nash *et al.* evaluated the CBCL with a sample of children diagnosed with FASD and ADHD⁹⁵. Greenbaum had previously shown that the CBCL was able to successfully distinguish between FASD and normal children⁹⁶. Parents of 54 children (11 FAS, 43 ARND) completed the CBCL. The CBCL has open-ended questions and a rating scale of 113 behavioural descriptors. Greenbaum had previously demonstrated in a sample of 35 children affected with ARND that there were significant differences in 62 items when compared to a control group of 35 matched for age, gender, and socioeconomic status⁹⁶. Twelve items were significantly different $p < 0.001$ ⁹⁶. These were 'acts too young for age', 'argues', 'can't concentrate=poor attention', 'can't sit still=restless=hyperactive', 'cruelty, bullying or meanness to others', 'disobedient at home', 'no guilt after misbehaving', 'impulsive=acts without thinking', 'lying or cheating', 'showing off=clowning', 'steals from home', and 'steals outside'. In this study the 12 items were scored. Seven of the 12 items strongly differentiated FASD children from ADHD and normal controls ($p < 0.001$)⁹⁵. They were "no guilt", "lying or cheating", "can't concentrate", "restless", "impulsive", "disobedient", and "acts young"⁹⁵. Six items differentiated the FAS/ARND from ADHD group ($P < 0.001$)⁹⁵. They were "no guilt", "cruelty", "acts young", "steals from home", "steals outside", and "lying or cheating"⁹⁵. A 86% sensitivity and 82% specificity were observed with 6 of the 7 items when comparing FASD, ADHD, and controls⁹⁵. A 81% sensitivity and 72% specificity were observed with 3 of 6 items when comparing FASD vs. ADHD group⁹⁵.

From these observations Nash *et al.* proposed that a FASD screening tool should be considered involving a 2-step approach: first identify behaviours suggesting FASD and then discriminate FASD from ADHD. The advantage of using this screening tool is that it specifically differentiates between FASD and ADHD. The limitation is that these are primary results which have not been replicated in a large sample size. In addition it has not been validated in different ethnicities or languages.

A new method of assessing the effect on physiological processes in individuals affected with FASD is by the use of ocular motor testing⁹⁷. Ocular motor tasks are sensitive tools for assessing executive function. Green *et al.* measured saccadic reaction times in FASD and control children 8–12 years⁹⁷. Children with FASD were observed to have elongated reaction times, excessive direction error, and no express saccades compared to controls⁹⁷. This tool is very early in its development and further investigation is warranted to establish its validity and reproducibility.

8. Justice System

The neurological impairments characteristic of persons affected by FASD including learning disabilities, poor judgment, impulsivity, increase the susceptibility to criminal behaviour and victimization⁹⁸. They may socialize with maladaptive or socially deviant children who are more accepting of their behaviours. As such there is a higher chance of persons affected by FASD to get into trouble with the law and become involved with the justice system⁹⁹. Identifying individuals in the corrections system affected with FASD is very important. In fact they often are involved with nonviolent crimes with repeated offences of failed compliance to parole conditions¹⁰⁰. Inherent disabilities may pose as a barrier to programs, skills learned, and/or treatment received while incarcerated⁹⁹. These include substance abuse treatment, anger management, vocational training. By identifying and understanding the neurobehavioural problems, programs can be developed that would result in altered sentencing or probation plans for offenders. Programs may be custom designed to the individuals' ability thereby improving the overall impact of the intervention. Identification is important in youth juvenile systems because early identification can prevent secondary disabilities¹⁰¹. This could result in future cost-savings to the corrections system and a decrease in future criminal activity¹⁰².

Systematic screening followed by diagnosis would assist in identifying affected individuals, thus enabling the tailoring of interventions during their incarceration and follow-up. A sensitive and specific screening procedure would only need to screen individuals once. Information required for screening would include access to medical records, childhood pictures, and past and current psycho-educational testing. Corrections systems staff would need to be trained in recognizing characteristics of individuals affected with FASD and trained on management strategies. Screening strategies include collecting height, weight, head circumference, analysis of facial photographs, exposure data, cognitive testing, educational assessments, behavioral data, sensory impairments, IQ or achievement testing.

Fast *et al.* reported their experiences with the ALARM in the criminal justice system. ALARM is a mnemonic that stands for adaptive behaviour, language, reasoning and memory. Impairment in these characteristics may be observed in a person with FASD. In a sample of 253 adolescents and adults affected with FASD, 60% had some contact with the law and 35% were incarcerated¹⁰³. Juvenile offenders alone comprised of 23% of the incarcerated individuals¹⁰³. The mean age of trouble with the law was reported at 12.8 years¹⁰³.

Conry *et al.* published the first prevalence estimate in correction population in British Columbia. Over a 1-year period youth undergoing forensic psychiatric inpatient assessment were assessed for FASD¹⁰⁴. 23.3% were diagnosed with FASD and 1% had a diagnosis of FAS¹⁰⁴.

Burd *et al.* reported that of 43 states or major city correctional facilities only Minnesota reported a FASD screening program¹⁰⁵. Only three states' correction facilities and one city's correction facility have access to diagnostic services for offenders who have FASD¹⁰⁵. To overcome this disparity they proposed four potential screening strategies for FASD in the correction system¹⁰⁶. They used the FAS Indicator tool as well as data from their records (IQ, data, height, weight, face) to screen offenders for FASD³⁴. The FAS Indicator tool is currently not validated and as such more research has to be undertaken. Option one is to screen five inmates who are most likely to have FAS¹⁰⁶. Option two is to screen 20–30 inmate records per day¹⁰⁶. Option three is to have a prospective screening program by a designated date where all person entering the system will be screened¹⁰⁶. Option four is to screen all

offenders in the facility using the tool¹⁰⁶. The advantages of conducting these investigations are the ability to determine the prevalence of FASD within correctional facilities, identify costs associated with the screening process, provide those who screen positive access to diagnosis, assess the sensitivity, specificity, and accuracy of the screening tool as well as the positive and negative predictive values. The major barrier to this form of screening is that there the lack of infrastructure and resources currently available. Implementation of this screening tool requires cooperation of the staff from receiving training to an increase in staff duties. Incomplete records will also pose as a barrier to the screening program. Once there are positive screens there are limited diagnostic facilities available. The other major barrier of screening is difficulty in obtaining the maternal history of alcohol exposure. As such, person with FAS are more likely to be identified compared to a person with ARND.

9. Diagnostic Capacity

Before the broad implementation of a screening tool, it is essential that the diagnostic capacity for FASD is available. Currently there is a 3–4 month wait time at some FASD diagnostic clinics¹⁰⁷. Goulden reported that in the adoption of the Canadian diagnostic guidelines for FASD, there would be an estimated 50% increase in the clinic workload¹⁰⁷. To our knowledge there has not been any investigation of this hypothesis. However, if a nationwide screening tool is implemented it is possible for diagnostic wait times to increase if the number of clinics do not increase because screening currently occurs in a small proportion of the population. Accessing diagnostic services could be difficult due to the lack of availability of clinics¹⁰⁸. In addition, rural residents need to travel to access clinics¹⁰⁸. The advances in technology have enabled the commencement of tele-diagnosis; however, there are limited professionals available. Difficulty obtaining stable funding has been a dilemma for many diagnostic clinics and additional funding would be required from the education ministry to fund school programs¹⁰⁷. Given the current limited resources, we need to utilize resources available in community and enhance support to individuals and families living in community (108).

10. Conclusion

The literature revealed several screening tools used to identify individuals with FASD. These include screening for the FAS facial phenotype, intrauterine growth restriction, ultrasound, EEG, MRI, DTI, meconium, hair, cord blood, psychological/neurobehavioural, and screening in the justice system. Screening for the FAS facial phenotype has been demonstrated to specifically identify individuals with FAS, however individuals with FASD who do not exhibit the facial phenotype will not be identified.

Screening for intrauterine growth restriction is too broad as it is associated with many conditions. Ultrasound screening, although easily accessible, has not been well studied to date. MRI and DTI are expensive methods of screening that are not easily accessible. Screening for FAEE in meconium shows promise as a screening tool, however it fails to capture first trimester alcohol exposure. Screening for FAEE in neonatal hair is still in the early stages of development and needs further validation before clinical implementation. Screening cord blood for elevated liver enzymes has not been demonstrated as an effective tool.

Psychological/neurobehavioural tests are usually conducted during the diagnostic process; however, the adapted questions arising from the CBCL test may prove to be an effective screening tool when

validated in a large and diverse population. Screening in the justice system is beneficial in effective sentencing of individuals; however screening tools have not been well researched.

Further research into FASD screening tools is required. Resources should be directed to improving current screening tools as well as identifying more specific screening tools. Evaluating screening tools should be an ongoing process. This will facilitate improvement of screening tools and validation across many populations and languages.

FASD is unique in the fact that some tests used to diagnose are also utilized as a screening tool. However it is important to emphasize that screening is not a brief diagnostic tool. The screening tool, if utilized correctly and with the adequate diagnostic facilities available, will expedite the efficiency of diagnosis. Identification of a successful screening tool may not be an easy task because of the complexity of neurobehavioural and developmental characteristics that are associated with FASD. Also, population variables including ethnicity and culture make the selection of an appropriate screening tool challenging. Perhaps a multifaceted screening approach will need to be taken. Once an appropriate screening tool(s) is identified, sustainability and evaluation of the tool must be undertaken.

11. References

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