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Universal school lunch programme closes a socioeconomic gap in fruit and vegetable intakes among school children in Japan

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Background: Universal school lunch programmes are expected to cover all children equally, compared with selective programmes that may stigmatize socially vulnerable children. However, the effectiveness of universal programmes in closing dietary disparity has not been empirically proven. We evaluated whether Japan's universal school lunch programmes contribute to a reduction in the socioeconomic status (SES)-related gradient in fruit and vegetable intakes. **Methods:** We analyzed data for 719 school children aged 6–12 years in a population-based survey conducted in the greater Tokyo metropolitan area. We measured dietary intakes using a validated self-administered brief diet history questionnaire for young children (BDHQ-10 y). We assessed parental education, annual household income and maternal employment status as SES indicators of children. We used multiple regression to estimate mean fruit and vegetable intakes by parental education and household income, and the contribution of school lunch to reducing the SES-related gradient in fruit and vegetable intakes. **Results:** Compared with children with high maternal education (>15 years), those with low maternal education (<13 years) had less vegetable intake by 22.3 g/1000 kcal (95% confidence interval = 12.5, 32.2) and less fruit intake by 7.5 g/1000 kcal (95% confidence interval = −2.4, 17.3). However, fruit and vegetable intakes from school lunch did not vary by SES, indicating that school lunch intake alleviated the SES-related gradient of total vegetable intake by 9.9% and that of fruit intake by 3.4%. **Conclusions:** Universal school lunch programmes can partially contribute to a reduction in the SES-related gradient in dietary intakes.

Introduction

Accumulated evidence shows that poor diet and unfavourable weight statuses are more prevalent among socioeconomically disadvantaged children.[1,2] More specifically, fruit and vegetable intakes were found to be lower among impoverished children than among their richer counterparts.[3–6] Because childhood diets affect health throughout life, measures to improve childhood diets are regarded as an important agenda in public health policies.

One strategy to improve the diet of children is to provide better access to nutritious food at schools. Evidence supports the notion that school lunch programmes improve diet quality and food security among children,[7–9] especially those of low socioeconomic status (SES).[9,10] School lunch programmes are often selectively provided to children with socioeconomic difficulties. This selective approach can efficiently reach populations in need but it may also run the risk of stigmatizing children of low SES among their peers.[11,12]

Universal school lunch programmes may close the socioeconomic disparity in nutrition among children in a more inclusive manner. In Japan, universal school lunch programmes have been implemented in the local municipalities in 1947[13] and expanded to cover 98.4% of all elementary school children under a strict standardized nationwide protocol for dietary contents.[14] In general, all children in the same school are served with the same menu, except for children with specific needs. All children have the lunch in a classroom with their teachers and peers, as Basic Law on Shokuiku has mentioned that the lunch is recognized as an opportunity for education on diet, social manners and socialization in Japanese primary education. The other features of school lunch in Japan were described elsewhere.[15] Although previous studies have shown that school lunch in Japan contributes to healthier nutrition intake among Japanese school children,[15,16] evidence is scarce on the effects of universal lunch programmes on reducing nutritional disparity among school children.

The National Health Nutrition Surveys in 2010 and 2014 revealed socioeconomic disparities in dietary intake, especially fruit and vegetable intakes, among Japanese adults,[17,18] and similar disparities are highly likely to exist among children. In this study, we aimed to (i) examine the levels of socioeconomic disparity in fruit and vegetable intakes among Japanese school children in metropolitan setting and (ii) evaluate whether universal school lunch programmes can close the gap if it exists.

Methods

Data sources

We used data from the Japanese Study on Stratification, Health, Income and Neighbourhood (J-SHINE). Details of J-SHINE were described elsewhere.[19] The participants were randomly selected from community-dwelling residential records of people aged 25–50 years in four municipalities in the greater Tokyo area. The original first-wave survey was conducted in 2010, followed by supplemental surveys for children aged under 18 years in 2011 and 2013. Among the 2428 participating children, we used the data for 868 school

children who went to public elementary schools (aged 6–12 years in Japan). We asked the participating children to answer a dietary habit questionnaire in 2013, the details of which are described briefly. We excluded dietary report data that included energy intake estimates in an outlier range ($n = 39$), following the criteria proposed in a previous study.[20] We also excluded data for children who lacked information on annual household income, parental education or maternal employment ($n = 110$). Consequently, we analyzed the data for 719 school children.

Measurements

Fruit and vegetable intakes

The J-SHINE survey assessed vegetable and fruit intakes and total energy intakes using the self-administered brief diet history questionnaire-10y (BDHQ-10y),[21] modified from a validated original BDHQ for adults.[22,23] The children themselves filled in the questionnaire, with help from their primary caretakers if necessary. The questionnaire initially examined the frequency of 54 food items from sources other than school lunch, assuming average portion sizes. The questionnaire then assessed food intakes from school lunch for six items (rice/bread, meat, fish, vegetables, fruit and milk) with a response set comprising 'rarely eat', 'leave half of dish', 'leave some of dish', 'eat all', 'sometimes have second helpings' and 'often have second helpings', by assuming a nationwide standardized protocol for food components of school lunch.[24,25] The total intake was estimated by adding the intake estimated from school lunch and that from other sources. The validity of the total fruit and vegetable intakes was confirmed by significant correlations with serum carotenoid concentrations in a previous study but not by the duplicate method.[21] Finally, we evaluated the contributions of school lunch to fruit and vegetable intakes per total daily intakes.

Socioeconomic status

Following the guidelines of a recent study on social determinants of health,[26] we used annual household income, maternal and paternal educational attainments and maternal employment status as indicators of children's SES. Although these indicators are likely to correlate with each other, we specifically used income as an indicator of household purchasing capacity while parental educational attainments reflected knowledge and attitude towards healthier eating habits. Maternal employment status may reflect availability for meal preparation, which can have a high impact on children's diet. Annual household income was assessed by 15 categories. We used the median value of each category and obtained an equivalent household income based on a previous study.[27] It was examined using six responses and re-categorized into three groups: low ($\leq$12 years), medium (13–15 years) and high ($\geq$16 years). It was examined by nine categories and re-categorized into four groups: full-time worker (manager/executive and regular employee), part-time worker (contract/temporary/fixed-term employee), homemaker (unemployment) and other job (self-employed, family worker).

Statistical analysis

After examining descriptive statistics, we performed multiple regression analyses for the outcomes of total daily intakes and share of school lunch-derived intakes per total intakes. We regarded SES indicators (household income, maternal and paternal educational attainments and maternal employment status) as main explanatory variables, adjusting for children's sex, age and municipality of residence as covariates because school lunch provision is under municipality management. We used robust standard errors to consider intraclass correlations among children in the same household. We conducted analyses with and without log-transformed values of outcomes and found similar results. Consequently, we report the results without log-transformation for ease of interpretation. Finally, we estimated least-square means of intakes by the levels of SES indicators. Throughout the analyses, we combined the data for girls and boys because our preliminary analyses showed similar values for the associations between SES and fruit and vegetable intakes in both sexes. All analyses were conducted using STATA statistical software, version 13.1 SE (Stata Corporation, Collage Station, TX).

Results

The mean age of the participants was 9.3 years, and 51.2% of the participants were boys. The mean vegetable intake was 209.4 g/day and the mean fruit intake was 123.4 g/day. Overall, 26% of mothers and 55% of fathers graduated from college or higher education (table 1).

Maternal education was significantly related to vegetable intake. By reference to children with high maternal education (>15 years), those with low maternal education (<13 years) were estimated to have 22.3 g [95% confidence interval (CI) = 12.5, 32.2] less vegetable intake per 1000 kcal intake. The corresponding value for fruit intake was −7.5 g (95% CI = −2.4, 17.3). Meanwhile, paternal education was not associated with both fruit and vegetable intakes (data not shown). Every 1 million yen unit increase in annual household income was associated with 2.4 g/1000 kcal (95% CI = 0.2, 4.6) more fruit intake (table 2). Among children with low maternal education, the share of school lunch in vegetable intake was 7.4% (95% CI = 4.2, 10.6) higher than that for children with high maternal education. The share of school lunch in fruit intake for children with higher household

Table 1 Participant characteristics

Variables		*n* (%) or mean (SD)
Children's characteristics	Boys	368 (51.2)
	Age	9.3 (1.7)
	1st grade	126 (17.5)
	2nd grade	106 (14.7)
	3rd grade	122 (17.0)
	4th grade	127 (17.5)
	5th grade	111 (15.4)
	6th grade	124 (17.2)
Dietary intake	Vegetable intake (g)	209.4 (88.3)
	Fruit intake (g)	123.4 (91.0)
	Vegetable intake (g/1000 kcal)	115.4 (47.0)
	Fruit intake (g/1000 kcal)	66.6 (45.4)
	Total energy intake (kcal)	1852 (431.3)
	Share of vegetable intake from school lunch (%)	39.1 (14.9)
	Share of fruit intake from school lunch (%)	20.6 (17.1)
Maternal education	Low (<13 years)	210 (29.6)
	Medium (13–15 years)	319 (44.4)
	High (>15 years)	190 (26.4)
Paternal education	Low (<13 years)	184 (25.6)
	Medium (13–15 years)	140 (19.5)
	High (>15 years)	395 (54.9)
Household income (million yen)		3.48 (1.6)
Maternal employment status	Full-time	78 (10.8)
	Part-time	228 (31.7)
	Homemaker	370 (51.5)
	Other job	43 (6.0)

Notes. SD, standard deviation. Share of vegetable intake from school lunch (%) = (vegetable intake from school lunch/total vegetable intake) × 100. Share of fruit intake from school lunch (%) = (fruit intake from school lunch/total fruit intake) × 100. Maternal employment status: 'homemaker' includes unemployment and 'other job' refers to self-employment or family worker.

Table 2 Associations of vegetable or fruit intake and share of vegetable or fruit intake from school lunch with SES by multiple regression analysis among school children in Japan ($n = 719$)

	Vegetable intake (g/1000 kcal)		Share of vegetable intake from school lunch (%)		Fruit intake (g/1000 kcal)		Share of fruit intake from school lunch (%)	
	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI	Coeff.	95% CI
Maternal education								
High (>15 years)	0.0	Ref.	0.0	Ref.	0.0	Ref.	0.0	Ref.
Medium (13–15 years)	−17.5	−26.1, −8.9	2.7	0.0, 5.3	−5.1	−13.7, 3.5	−0.6	−3.6, 2.5
Low (<13 years)	−22.3	−32.2, −12.5	7.4	4.2, 10.6	−7.5	−17.3, 2.4	4.2	−0.5, 8.8
Household income (per 1 million yen)	−1.1	−3.5, 1.3	0.0	−0.7, 0.8	2.4	0.2, 4.6	−0.8	−1.6, 0.0
Maternal employment status								
Full-time	0.0	Ref.	0.0	Ref.	0.0	Ref.	0.0	Ref.
Part-time	5.5	−7.3, 18.2	−2.2	−6.5, 2.2	−1.4	−11.9, 9.1	0.5	−3.3, 4.4
Homemaker	3.1	−8.2, 14.4	−1.6	−5.8, 2.5	4.8	−6.1, 15.6	1.0	−2.7, 4.8
Other job	−10.0	−2.4, 1.5	0.3	−5.9, 6.5	2.0	18.7, 22.7	5.7	2.0, 13.4

Notes. CI, confidence interval; Coeff., coefficient. Share of vegetable intake from school lunch (%) = (vegetable intake from school lunch/total vegetable intake) × 100. Share of fruit intake from school lunch (%) = (fruit intake from school lunch/total fruit intake) × 100. Adjustment for: age, sex and municipality of residence.

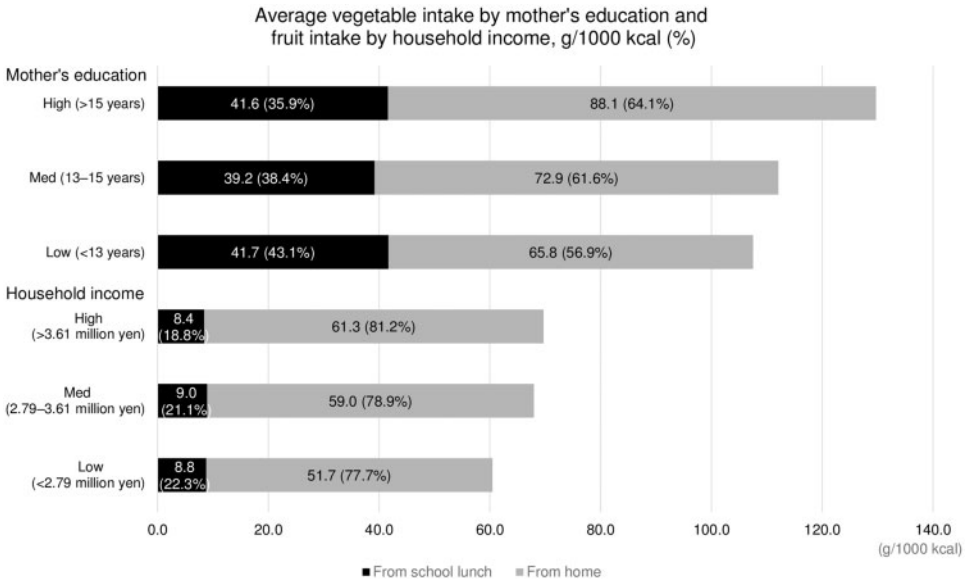

Figure 1 Average vegetable and fruit intake by household SESs, adjusting for all other socioeconomic indicators, children's sex and age and municipality of residence

income was 0.8% (95% CI = −1.6, 0.0) lower than that for children with lower household income (table 2).

The fruit and vegetable intakes from school lunch did not vary large by SES, despite the existence of SES-based differences in the total amounts of fruit and vegetable intakes (figure 1). Thus, school lunch contributed to a reduction in the inequality of vegetable intake by 9.9% and fruit intake by 3.4% (table 3).

Discussion

The key findings of this study are as follows. First, maternal education was associated with overall fruit and vegetable intakes independently of other individual and household sociodemographic characteristics, while paternal education was not. Household income was only associated with fruit intake. These results are consistent with those of previous studies conducted in Western countries, showing that maternal education is positively associated with fruit and vegetable intakes among school children.[3–6,28] Second, we demonstrated that children whose mothers were less educated had greater reliance on school lunch for their vegetable intake, and children with lower household income had more contribution from school lunch to their fruit intake. However, because the serving of fruit in school lunches as well as overall fruit intake is low in Japan compared with Western countries,[29] the attributable effects of school lunch in reducing the socioeconomic disparity in regard to fruit intake may be limited.

Our study adds new evidence that universal school lunch programmes are effective in at least partially reducing the gap in diet across parental SES. Lower socioeconomic children had less access to high quality and balanced meals at home, and universal school lunch programmes may provide greater contributions to children in lower socioeconomic conditions.

In our study, maternal education had stronger associations with fruit and vegetable intakes than paternal education. This may reflect the notion that the person who usually cooks at home affects the nutritional intake of their children. In the majority of Japanese households, mothers are more likely to prepare most meals for their children. According to a government nationwide survey comprising a general survey of social life, women spend 2.5 h/day on housekeeping including meal preparation, while men spend only 0.3 h/day.[30]

Household income was also associated with fruit intake. Fruits might be considered 'luxury items'. This was reflected by the

Table 3 Average total vegetable intake, vegetable intake from home by maternal education and average total fruit intake, fruit intake from home by household income, adjusting for all SES indicators, children's sex and age and municipality of residence

	Maternal education		Household income		Ratio of high/low	Change of ratio (%)
	High (>15 years)	Low (<13 years)	High (>3.61 million yen)	Low (<2.79 million yen)		
Total vegetable intake (g/1000 kcal)	129.7	107.5			1.21	9.89
Vegetable intake from home (g/1000 kcal)	88.1	65.8			1.34	
Total fruit intake (g/1000 kcal)			69.7	60.5	1.15	3.36
Fruit intake from home (g/1000 kcal)			61.3	51.5	1.19	

governmental survey of price elasticity that categorized fruit and snacks as amenity foods.[31] Additionally, maternal skills and knowledge on diet may have less effect on their children's fruit intake than on their vegetable intake. The correlation between vegetable intake and income was not statistically significant. This was not consistent with the National Health and Nutrition Survey.[17,18] A potential explanation of the inconsistency may be the difference in age distribution between the groups. This study focuses on children, who are more influenced by parental food choices and household characteristics. Alternatively, the measurement of income is significantly different between the studies. The National Surveys used only three categories ($\leq$2 million yen, 2–6 million yen, $\leq$6 million yen) when determining household income, potentially more vulnerable to error. Further studies are needed to conclude the correlation between vegetable intake and household income in Japanese children.

Given that maternal education may reflect their skills and knowledge on diet to serve healthy meals, it is plausible that mothers with lower educational attainment may have difficulties in regularly providing balanced meals at home. Maternal food preferences may also affect children's diet. Evidence suggests strong correlations between mothers and children in their vegetable and fruit consumptions.[5,32–34] Thus, the socioeconomic gap in dietary intakes among children is likely to be mainly derived from their home intakes.

However, we found that SES did not impact fruit and vegetable intake from school lunch. These findings are particularly noteworthy because they strongly suggest that universal school lunch programmes could equally provide the opportunities for fruit and vegetable intake to all children regardless of their SES. Nonetheless, SES-based disparity remained at 22.3 g/1000 kcal for vegetable intake and 7.5 g/1000 kcal for fruit intake between low and high maternal educational attainments. To further reduce these gaps, additional measures to secure more availability and accessibility of fruit and vegetables through school meal programmes[35] and other sources including home intakes are warranted. For example, providing opportunities for children, in community settings, to eat balanced meals for breakfast and dinner that are free or available at affordable prices may help to further reduce the health disparity in diets.[36] Nutrition and cooking education during early childhood may also contribute to children acquiring cooking skills and nutritional knowledge regardless of their SES.[37]

We used adjusted values for total and school lunch-derived fruit and vegetable intake per 1000 kcal to account for age-related variation in caloric intake. In studies in the USA, children of lower SES have been found to have higher energy intake due to excess portions and snacking. In this case, it may be more important to reduce caloric intake rather than enhance vegetable intake. However, studies in Japan[38] have not shown a clear correlation between children's SES and energy intake. In our sample, energy intake was slightly higher among children of higher household income.

There are limitations to this study. First, the generalizability of the study may be limited because all participants were selected from four municipalities in the greater Tokyo metropolitan area.[39] Further studies should evaluate the effectiveness of universal school lunch programmes in other settings in terms of place, culture and quality of lunch. Second, the validity of fruit and vegetable intakes specifically from school lunch estimated by the BDHQ-10y has not yet been examined. Compared with a school nutrition report in 2015,[40] the total vegetable intake from school lunch was 17.5 g less in this study, while the total fruit intake from school lunch did not differ much. These data partly support the validity of the BDHQ-10y as a tool for nutritional analysis of Japanese school lunch. Third, some younger children were helped to answer dietary habit questionnaire, which may be susceptible to reporting bias by their mothers, especially with higher education and consciousness about healthy diet. However, sub-analysis limited to those that children answered by themselves did not make change in the results. Household income and parental education were self-reported; therefore, the possibility of misclassification exists. Furthermore, we did not have information about the curricula of the schools, which may have an effect on student eating habits. School lunch programmes were highly standardized by each municipality's education authority under the School Lunch Program Act. Hence, we included municipality dummy codes in our regression analysis to incorporate any fixed effects related to differences between municipalities.

Achievement of standardized universal school lunch programmes is a challenge. Sustainability in food logistics systems and financing for nationwide universal school lunch programmes are other topics to be investigated. Other challenges in universal school lunch programmes are the costs required to meet various needs for food preferences based on religious and cultural diversity in schools. Studies investigating the cost-effectiveness of universal lunch programmes are warranted. Although there are some challenges, notwithstanding this successful case in Japan—where the school lunch program was started in 1947 under the support of United Nations Children's Fund (UNICEF) and the School Lunch Law was established in 1954—we believe that the promotion of universal school lunch programmes can be an effective vehicle for closing the nutrition-associated gap in schoolchildren overcoming socioeconomic challenges.

Conclusion

In this study, we demonstrated the effectiveness of standardized universal school lunch programmes in partially reducing the maternal–education-related gradient in vegetable intake and household income-related fruit intakes in the Japanese elementary school setting. Additional community interventions may be needed to further close the gap in children's dietary intake.

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Conflicts of interest: None declared.

Key points

- Parental SES was associated with overall fruit and vegetable intakes.
- Children whose mothers were less educated had greater reliance on school lunch for their vegetable intake.
- Children with lower household income had more contribution from school lunch to their fruit intake.
- Universal school lunch programmes can in part contribute to a reduction in the SES-related gradient in diets.

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Infant abuse diagnosis associated with abusive head trauma criteria: incidence increase due to overdiagnosis?

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Background: The hypothesis of this study is that the diagnosis of infant abuse is associated with criteria for shaken baby syndrome (SBS)/abusive head trauma (AHT), and that that changes in incidence of abuse diagnosis in infants may be due to increased awareness of SBS/AHT criteria. **Methods:** This was a population-based register study. Setting: Register study using the Swedish Patient Register, Medical Birth Register, and Cause of Death Register. The diagnosis of infant abuse was based on the International Classification of Diseases, 9th and 10th revision. Participants: All children born in Sweden during 1987–2014 with a follow-up until 1 year of age ($N = 2\,868\,933$). SBS/AHT criteria: subdural haemorrhage, cerebral contusion, skull fracture, convulsions, retinal haemorrhage, fractures rib and long bones. Outcomes: Incidence, rate ratios, aetiologic fractions and Probit regression analysis. **Results:** Diagnosis of infant abuse was strongly associated with SBS/AHT criteria, but not risk exposure as region, foreign-born mother, being born preterm, multiple birth and small for gestational age. The incidence of infant abuse has increased tenfold in Sweden since the 1990s and has doubled since 2008, from 12.0 per 100 000 infants during 1997–2007 to 26.5/100 000 during 2008–2014, with pronounced regional disparities. **Conclusions:** Diagnosis of infant abuse is related to SBS/AHT criteria. The increase in incidence coincides with increased medical preparedness to make a diagnosis of SBS/AHT. Hidden statistics and a real increase in abuse are less plausible. Whether the increase is due to overdiagnosis cannot be answered with certainty, but the possibility raises ethical and medico-legal concerns.

Introduction

In 1962 battered child syndrome was first described in a clinical study.[1] In 1972 it was proposed that subdural haematomas could be caused by whiplash shaking[2] and in 1974 the term 'shaken baby syndrome (SBS)' was coined to describe a condition inflicted by violent shaking and identified by the triad retinal haemorrhage, subdural haemorrhage and encephalopathy.[3] The diagnosis of abusive head trauma (AHT), departing from the three diagnostic criteria for SBS, now has a broader categorization that may also include apnoea, seizures, fractures of the skull, metaphyses and shaft of long bones and ribs, and inability of parents/carers to provide an explanation for accidental trauma, the former findings and symptoms being considered highly specific for non-accidental trauma.[4–7]

Shaken baby syndrome/AHT is not a diagnosis classified in the International Classification of Diseases (ICD-9/ICD-10); however, physical abuse and battered baby or child syndrome is defined as maltreatment syndrome. In an intercountry epidemiological study, Gilbert et al. described the maltreatment syndrome/assault and included in their classification the diagnoses of intracranial injury and long bone fractures.[8]

The incidence of maltreatment syndrome has shown a variation by country,[8] from 11.5 per 100 000 infants in Sweden (1987–2009), to 34.6 in England (1997–2008), to 118.9 in Western Australia (1980–2005), with only England showing a declining trend.[8] The incidence of non-fatal AHT among infants, based on the case definition of the US Center of Disease Control and Prevention (CDC), was 32.3 per 100 000,[9] while a Canadian study on infant AHT found an incidence of 13.0–15.5 for 2002–2007.[10] In Scotland in 1998–1999, the incidence of shaken impact syndrome among infants was 24.6 per 100 000.[11]

Shaken baby syndrome has, since 1997,[12] been questioned as a diagnostic entity, and emerging imaging technology demands further differential diagnostic considerations.[13–18] Furthermore, the precision of the SBS/AHT diagnosis is lost when excluding the diagnostic criterion of incompatibility between the carer's report of history and the investigating doctor's interpretation of the findings.[19] In 2016, a systematic literature review by the Swedish Agency for Health Technology Assessment and Assessment of Social Service (SBU) concluded that there is limited scientific evidence that the triad can be explained by isolated shaking, and that there is insufficient evidence to assess the diagnostic accuracy of the triad to identify SBS/AHT.[20,21]