The nutritional status of children living within institutionalized care: a systematic review (#38892)

First revision

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- Methods described with sufficient detail & information to replicate.

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The nutritional status of children living within institutionalized care: a systematic review

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Background. There are an estimated 2.7 million children living within institutionalized care worldwide. This review aimed to evaluate currently available data on the nutrition status of children living within institutionalized care.

Methods. We searched four databases (Pubmed/Medline, CINHAL Plus, Embase and Global Health Database) for relevant articles published from January 1990 to February 2019. Studies that included information on anthropometry or micronutrient status of children living within institutionalized care were eligible for inclusion. The review is registered on PROSPERO: CRD42019117103.

Results. From 3,602 titles screened, we reviewed 98 full texts and 25 papers were eligible. Two (8%) studies reported data from multiple countries, nine (36%) were from Asia, four (16%) from Africa, three (12%) from Eastern Europe, four (16%) from the European Union and one (4%) from each of the remaining regions (Middle East, South America and the Caribbean). Twenty-two (88%) were cross sectional. Ten (40%) of the studies focused on children >5 years, seven (28%) on children <5 years, seven (28%) covered a wide age range and one did not include ages. Low birth weight ranged from 25-39%. Only five (20%) included information on children with disabilities reporting prevalence from 8-70%. Prevalence of undernutrition varied between ages, sites and countries: stunting ranged from 9-72%; wasting from 0-27%; underweight from 7-79%; low BMI from 5-27%. Overweight/obesity ranged from 10-32% and small head circumference from 17-41%. The prevalence of HIV was between 2-23% and anemia from 3-90%. Skin conditions or infections ranged between 10-31% and parasites from 6-76%. Half the studies with dietary information found inadequate intake or diet diversity. Younger children were typically more malnourished than older children, with a few exceptions. Institution-based children were more malnourished than community peers, although community children were also often below growth standards. High risk of bias was found.

Conclusions. This study highlights the limited amount of evidence-based data available on the

nutritional status of children in institutions. Of the studies reviewed, children living within institutionalized care were commonly malnourished, with undernutrition affecting young children particularly. Micronutrient deficiencies and obesity were also prevalent. Data quality was often poor: as well as suboptimal reporting of anthropometry, few looked for or described disabilities, despite this being common in this population and having a large potential impact on nutrition status. Taken together, these findings suggest a need for greater focus on improving nutrition for younger children, especially those with disabilities. More information about children's nutrition status is needed to support the millions of children living within institutionalized care to fully address their right and need for healthy development.

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32   **Abstract**

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34   worldwide. This review aimed to evaluate currently available data on the nutrition status of
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59   institutionalized care were commonly malnourished, with undernutrition affecting young
60   children particularly. Micronutrient deficiencies and obesity were also prevalent. Data quality
61   was often poor: as well as suboptimal reporting of anthropometry, few looked for or described
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64   nutrition for younger children, especially those with disabilities. More information about
65   children's nutrition status is needed to support the millions of children living within
66   institutionalized care to fully address their right and need for healthy development.

67

Introduction

Malnutrition impacts millions of children around the world (Black et al. 2013; The World Bank Group; UNICEF April 2019). In 2018 for children younger than 5 years old, 49 million children were wasted, just under one in four (21.9%) were stunted and 5.9% of children were overweight (UNICEF April 2019). Almost half of the deaths among children younger than 5 years old have undernutrition as an underlying factor (Black et al. 2013; UNICEF April 2019). In some countries, up to half of adolescents are stunted, as many as 11% are too thin, up to 5% are obese and over 50% are anemic (Black et al. 2013). Being malnourished has many adverse consequences including increased risk and severity of infections, increased risk of disability, and death (Black et al. 2013; Groce et al. 2014; McDonald et al. 2013; Myatt et al. 2018). There is a cyclical interaction between infections and undernutrition which leads to poor nutritional status and illnesses. The first 1,000 days of a child's life are particularly important because poor nutrition at this stage also predisposes children to long-term impairments such as stunted growth, impaired cognition and poor performance at school and work (Black et al. 2013; UNICEF April 2019).

Some children are at high risk of malnutrition, such as orphans and children living within institutionalized care (UNICEF April 2019). UNICEF estimates that there are some 140 million orphans worldwide who have lost either one or both of their parents (UNICEF 2017). Although most orphans live with other family members, some live in institutionalized care or residential care facilities (UNICEF 2017). Institutionalized care is defined by the United Nations as residential care that is provided in any non-family-based group setting, including all other short- and long-term residential care facilities (United Nations General Assembly 2009). Many non-orphans live in institutionalized care for a variety of reasons, such as social or economic (Marinus H van IJzendoorn 2011; The Children's Health Care Collaborative Study Group 1994). These children are also vulnerable (Baron et al. 2001; The Children's Health Care Collaborative Study Group 1994). Though family-based care is the ideal environment for all children, this is not always possible (Petrowski et al. 2017; The Children's Health Care Collaborative Study Group 1994).

Approximately 2.7 million children ages 17 years and younger live in residential care globally: 120 children per 100,000 (Petrowski et al. 2017). The UN Convention on the Rights of the Child states that when it is in a child's best interest and they cannot remain in their family, alternative-care options need to be provided for the child. Alternative-care solutions can include foster care or institutional care. These alternative-care options need to meet a standard of living adequate for a child's full development, including children with disabilities; particularly in regard to education, health, development, nutrition and other essentials (United Nations Human Rights Office of the High Commissioner 1990).

Children in institutional care often face numerous adversities prior to admission and many enter institutionalized care with pre-existing nutritional, developmental, medical and neurological needs (Baron et al. 2001; The Children's Health Care Collaborative Study Group 1994; The St. Petersburg-USA Orphanage Research Team 2005; The St. Petersburg-USA Orphanage Research Team 2008). Some have disabilities or were born prematurely or with low birth weight and many

109　have had exposure to drugs or alcohol, HIV, stress or a range of other issues — all of which can
110　impact their health. (Baron et al. 2001; Groce et al. 2014; The Children's Health Care
111　Collaborative Study Group 1994; The St. Petersburg-USA Orphanage Research Team 2008).
112　Often there is limited or no information about children's early lives or exposures prior to coming
113　into care (The Children's Health Care Collaborative Study Group 1994; The St. Petersburg-USA
114　Orphanage Research Team 2005; The St. Petersburg-USA Orphanage Research Team 2008).
115　Those entering institutionalized care may experience further negative issues when admitted:
116　ongoing risk of suboptimal nutrition, poor growth or growth failure, neglect or abuse, impacted
117　physical and mental development, infections and diseases because of the conditions in the care
118　centers (Frank et al. 1996; Johnson & Gunnar 2011; The Children's Health Care Collaborative
119　Study Group 1994). Disability can be both a contributing factor and a result of malnutrition. In
120　addition, disabilities, micronutrient deficiencies and malnutrition can all lead to increased
121　morbidities and mortality (Groce et al. 2014; McDonald et al. 2013; Myatt et al. 2018).

122　Often because of limited staffing, time and fiscal constraints, institutions are able to only provide
123　basic care needs for children instead of addressing children's individual needs for healthy and
124　full development (Marinus H van IJzendoorn 2011; Whetten et al. 2014). Factors impacting
125　children's nutrition status in care centers include inadequate or poor quality of food or
126　inappropriate types of food; inadequate stimulation or attention; improper use of medications;
127　inappropriate feeding practices; and poor hygiene and sanitation leading to frequent illnesses and
128　negatively impacting utilization of nutrients (Frank et al. 1996; Marinus H van IJzendoorn 2011;
129　The St. Petersburg-USA Orphanage Research Team 2008).

130

131 **Methods**

132 The aim of our review was to better understand the current nutritional status of children in care
133 by looking at anthropometric and nutritional status indicators in relation to age, disability,
134 geography, gender and related factors, with an ultimate goal of improving policy and practice to
135 better meet the needs of this unique and vulnerable population.

136 We analyzed existing published peer-reviewed literature on nutrition status of children in
137 institutional care by examining anthropometric data and micronutrient status and other factors
138 including disability status, gender and age. PRISMA guidelines were followed throughout the
139 review process and a PROSPERO registration was completed prior to the start of the study
140 (PROSPERO 2019: CRD42019117103,
141 https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=117103) (Moher et al.
142 2009; National Institute for Health Research 2019).

143 The review primarily evaluated observational and intervention studies. Inclusion criteria
144 included material which was published between January 1990 and January 2019 in English and
145 contained research related to orphanages/institutionalized care, children, nutrition,
146 anthropometric data or micronutrient status. We selected these dates because the Convention on
147 the Rights of the Child went into effect in 1990, and since then, there have been significant
148 changes in institutional care and changes in the understanding of the needs of children in
149 institution-based care (IBC) (Frank et al. 1996; United Nations Human Rights Office of the High
150 Commissioner).

151 In order to be included in this review, the studies must have addressed a population of children
152 younger than 18 years old (with the exception of one study which included children as old as 20
153 years but was retained for informational value), been peer reviewed and included at least one
154 measurement of nutrition status through standardized tools, such as WHO Growth Standards or
155 WHO Growth References and definitions (World Health Organization 2019a; World Health
156 Organization 2019b). Anthropometric indicators of interest included: weight for age,
157 length/height for age, weight for length/height, head circumference for age and mid-upper arm
158 circumference for age. Micronutrient status, clinical signs/symptoms and dietary information was
159 also included when available. Emily DeLacey, the principal investigator, and Dr. Marko Kerac
160 determined and used the search strategy. Four electronic databases were searched through OVID
161 from December 2018 through January 2019: Pubmed/Medline, CINHAL Plus, Embase and
162 Global Health Database. For details of our search strategy, see Appendix 1. Initial article
163 screening was based on title and abstract, following which, full texts were assessed for eligibility
164 against our pre-specified inclusion/exclusion criteria. Discussions with the research team
165 resolved any questions of eligibility, with Dr. Cally Tann deciding any discords. A data
166 extraction table was used to summarize key information from the final selection of articles into
167 tables and columns organized by related themes and areas.

168 Nutritional status was determined according to reported anthropometry, whether reported by z-
169 scores (standard deviations from a reference population), or percentiles. Micronutrient status and
170 intake was also reported on and included prevalence of anemia or micronutrient deficiencies.
171 Other key data areas included disability status, birth weight, sex, age, dietary intake and any

172   reported disease, illness or infection which could impact nutrition status. Heterogeneity in the
173   type of interventions prevented our ability to conduct a meta-analysis of the study, so a narrative
174   synthesis was used.

175

176 **Results**

177 We found a total of 3,973 papers. After 371 duplicates were removed, the remaining 3,602, were
178 screened by title and abstract. All but 98 articles were excluded during this phase. Of the 98
179 identified as potentially eligible, we were unable to locate seven, 53 had insufficient
180 anthropometry or used non-standard measurements, 10 did not have appropriate population or
181 study type and three were excluded because the anthropometric data existed in another study.
182 Twenty-five studies met our inclusion criteria (Figure 1). Most studies (22, 88%) were cross
183 sectional (Table 1). The most commonly researched region was Asia with nine studies (36%),
184 followed by Africa with four studies (16%). Three (12%) were from Eastern Europe, four (16%)
185 from the European Union and one (4%) from each of the remaining regions (Middle East, South
186 America and the Caribbean). Kenya and India were the most commonly researched countries and
187 were each included in four studies (Table 1). Ten (40%) focused on children older than 5 years,
188 seven (28%) on children younger than 5 years, seven (28%) covered a wide age range and one
189 did not include ages. Twelve (48%) included control or comparison groups of children who were
190 community children (CC) or orphaned, separated or abandoned children living in family-based
191 care (FBC), or children living on the streets (CLS). Control groups were typically orphaned
192 children living in family-based care (FBC) or community children (CC) with no history of
193 institutional care and the groups were selected from different settings including from local
194 schools, communities, clinics or hospitals, lists, house-to-house census or other child-related
195 programs (Braitstein et al. 2013; Johnson et al. 2010; Whetten et al. 2014). Eight (32%) studies
196 mentioned or analyzed gender differences (Table 1 and 2). A history of low birth weight (LBW)
197 was also common (25% to 39%).

198 Children with Disabilities

199 Of the 25 studies reviewed, 12 (48%) did not state whether they included children with
200 disabilities (Table 1 and 2). Eight (32%) of the studies stated that children with disabilities were
201 excluded, leaving only five (20%) mentioning children with disabilities in their reporting, but
202 either excluded them from analysis or did not state whether or not they were excluded. Only one
203 study included any anthropometric measurements for children with disabilities (Lewindon et al.
204 1997). The St. Petersburg-USA Orphanage Research Team found that 21% of children had
205 disabilities (The St. Petersburg-USA Orphanage Research Team 2005). Miller and colleagues
206 found 16% of institution-based children (IBC) had significant disabilities and 70% had
207 developmental delays (Miller et al. 2006).

208 Anthropometrics

209 Undernutrition, micronutrient deficiencies and overweight/obesity were reported in varying
210 ways. Prevalence of undernutrition differed markedly: stunting (low length/height for age) from
211 9 to 72%; wasting (low weight for length/height) from 0 to 27%; underweight (low weight for
212 age) from 7 to 79%; low BMI (body mass index) ranged from 5 to 27% (Table 2). Ten to 32% of
213 children were overweight or obese. Panpanich et al. found children younger than 5 years old to
214 be more stunted, wasted and underweight than older children and below WHO growth standards
215 (Panpanich et al. 1999). The prevalence of small head circumference ranged from 17 to 41%.

216   Micronutrients, clinical signs/symptoms and infections

217   Clinical signs or symptoms were reported in 48% (12) of the studies (Table 3). Five (20%)
218   mentioned HIV but two of these were conducted in institutions for children with HIV
219   (Kapavarapu et al. 2012; Myint et al. 2012). Excluding the facilities for children with HIV, HIV
220   prevalence was 2 to 23%. One study found a higher prevalence of morbidity among children in
221   IBC than CC (p<0.05) (Mwaniki et al. 2014).The prevalence of parasites ranged between 6 to
222   76%, with Lesho and colleagues finding 10% of children in IBC having three or more parasites
223   (Lesho et al. 2002). Skin infections, varicella zoster, tuberculosis, impetigo, dental issues,
224   ear/nose/throat problems, respiratory infections, diarrhea and other conditions or illnesses were
225   frequently reported among IBC (Table 3). Skin conditions or infections ranged between 10 to
226   31% and Kapavarapu and colleagues found 75% of children had an infection within the first
227   three months of admission to a site (Kapavarapu et al. 2012). Seven (28%) reported on
228   micronutrient status or intake and the prevalence of anemia ranged from 3 to 90%. Hearst and
229   colleagues found over a third of children had low vitamin D (Hearst et al. 2014). Other
230   micronutrient deficiencies discussed included iodine, zinc, albumin, as well as vitamins A and B
231   (Table 3). Edema, conjunctival pallor, xerophthalmia and goiters were found more in children in
232   IBC than those living in FBC (Aboud et al. 1991).

233   Dietary diversity, intake and food security

234   Eight (32%) studies discussed dietary diversity, intake or food security (Table 3). Mwaniki and
235   colleagues found that diet diversity was lower in children living in IBC than for CC (p<0.05).
236   Diets were reported to have a high reliance on starches and legumes (Mwaniki et al. 2014). Of
237   the studies that assessed dietary intake, 50% found adequate intake. Dietary adequacy varied;
238   from children in IBC at 3.9 times higher risk of consuming inadequate calories to having 362%
239   higher intake than estimated average requirements for some nutrients. The one study which
240   reported on food security found that children in IBC had higher food security when compared to
241   children in FBC, 42% vs. 2% (Braitstein et al. 2013).

242   **Discussion**

243   The nutritional status of children living in institutions has the potential to adversely impact their
244   health and well-being, yet out of 3,602 papers from four major databases, only 25 peer-reviewed
245   papers presented evidence based findings on the children's nutrition status (Figure 1). All 25
246   reviewed studies indicated that many of the children in institutionalized care faced some form of
247   malnutrition. The available data suggests that children living within institutionalized care are
248   commonly malnourished: affected by both undernutrition, overweight and micronutrient
249   deficiencies. With few exceptions, mostly of older children, children living within
250   institutionalized care were significantly below standards for growth, diet and micronutrient status
251   and were often below comparison groups of their community peers. Nutrition status varied
252   between care centers and between the ages of children, with younger children at a higher risk of
253   being malnourished. There may be a number of reasons why this is the case, such as younger
254   children have a harder time feeding themselves, especially if disabilities are present, and young,
255   poorly nourished children are at risk of not surviving to become older children in institutional
256   settings (McDonald et al. 2013; Myatt et al. 2018; The Children's Health Care Collaborative
257   Study Group 1994). Diet inadequacy, micronutrient deficiencies and illnesses or infections were
258   also found to be prevalent in children of all ages.

259   To our knowledge, this is the first systematic review on the nutrition status of children living
260   within institutionalized care. It is important because 2.7 million children worldwide live in IBC
261   and there are a multitude of factors and reasons why they may be affected by different types of
262   malnutrition. The extent and direction of this has not been well studied nor is it currently being
263   effectively monitored or assessed (Petrowski et al. 2017). Representing an inherently high-risk
264   population, there are many reasons why we would expect undernutrition to be common: this was
265   indeed observed in our review. Conversely, there are some reasons why IBC may offer
266   opportunities for good nutrition and access to services, such as better food security, more reliable
267   funding sources and access to specialized therapy or treatment. These ideal factors may not be
268   possible or available for families affected by different economic circumstances living in the same
269   communities (Braitstein et al. 2013; Panpanich et al. 1999; Whetten et al. 2014).

270   Our review, which used a comprehensive search strategy, also notably highlights a lack of well
271   reported and standardized evidence. Only 19 countries were represented in our findings, despite
272   Petrowski and colleagues finding 140 countries with data on children in institutions and this
273   limited our ability to determine trends or region-specific patterns and risk factors (Petrowski et
274   al. 2017).

275   <u>Children with disabilities and children with low birth weight</u>

276   A key observation is that few studies mentioned children with disabilities and only one included
277   anthropometric analysis (Table 1 and 2) (Lewindon et al. 1997). Children with disabilities are
278   disproportionately present in institutionalized care settings. (Baron et al. 2001; The Children's
279   Health Care Collaborative Study Group 1994; The St. Petersburg-USA Orphanage Research
280   Team 2005). They are already at increased risk when they enter care centers because disabilities
281   can increase the likelihood of being malnourished due to feeding challenges, malabsorption

282 and/or intake needs. In addition, children with disabilities face the risk of their disabilities
283 worsening in environments that do not meet their individual needs (Groce et al. 2014; Kroupina
284 et al. 2014). Children with some types of disabilities may have higher caloric needs or require
285 specialized diets or additional supports at mealtimes (Groce et al. 2014; Johnson & Gunnar 2011;
286 Johnson et al. 2010; Kroupina et al. 2014; The Children's Health Care Collaborative Study
287 Group 1994; The St. Petersburg-USA Orphanage Research Team 2008).

288 Children in care or those who stay in care the longest may have more disabilities, more
289 underlying diseases or more complex backgrounds – including a history of low birth weight
290 (LBW) and therefore may require more focused care (The Children's Health Care Collaborative
291 Study Group 1994; The St. Petersburg- USA Orphanage Research Team 2005). Even when
292 provided with adequate diet and medical care, these groups may be more dependent on
293 caregivers for feeding, or need specialized approaches to feeding such as supportive seating and
294 positioning, adaptive skill development and an extended time to eat (Johnson & Gunnar 2011).
295 When children enter into care they are often in poor health and those that stay the longest, such
296 as children with disabilities, are frequently in worse condition compared to children who are
297 healthy at admission (Groce et al. 2014, The St. Petersburg-USA Orphanage Research Team
298 2005). This is all important to highlight because becoming malnourished while living in an
299 institution can also increase the risk of children developing a disability (Groce et al. 2014).

300 High rates of low birth weight infants in institutions were common; although child history,
301 records or tracking were often limited (Johnson et al. 2010; Kroupina et al. 2014; The Children's
302 Health Care Collaborative Study Group 1994; The St. Petersburg-USA Orphanage Research
303 Team 2005). Health status at birth was found to be a significant determinant of development and
304 growth trajectories and pre- and perinatal circumstances influence children's development in
305 care: nutrition needs vary depending on individual growth rates and the presence of preexisting
306 nutrition deficiencies (Johnson et al. 2010; Kroupina et al. 2014; Martins et al. 2013). Johnson &
307 Gunnar and Johnson et al. found that during early rapid-growth phases, the effects of even
308 modest nutritional deficits can become magnified (Johnson & Gunnar 2011; Johnson et al.
309 2010). Age, age at admission and length of stay were other key factors identified that were
310 associated with nutritional status (Chowdhury et al. 2017; Kroupina et al. 2014; Martins et al.
311 2013; Panpanich et al. 1999).

312 Gender and malnutrition

313 Gender is also important to consider because programs and policies should be evidence-based
314 and equitable, offering support to those most in need (Theobald et al. 2017). However, our
315 review found that only nine of the studies compared genders. Of these, two found that girls were
316 more malnourished, three found boys were more malnourished than girls and another four found
317 both groups had similarly high prevalence of malnutrition or no significant difference in
318 nutritional status by gender. We thus have mixed and inconclusive evidence of malnutrition or
319 risk of malnutrition being linked to gender of children in institutional care (Table 2). This may be
320 a very context specific issue where social as well as biological factors play a role.

321 Anthropometrics

322   Frequently the prevalence of low birth weight, stunting, wasting, underweight, anemia, and
323   overweight was higher in IBC compared to the global prevalence for children younger than 5
324   years old (The World Bank Group). Paralleling global trends, the triple burden of malnutrition
325   also needs to be examined in IBC (Black et al. 2013; UNICEF April 2019). Although only a few
326   studies reported on overweight, when it was reported, the prevalence was high, especially for
327   adolescents. Future studies should report on overweight as well as underweight. A positive
328   feature of the studies reviewed was that many had peer groups for comparison; this is helpful
329   because many children in the surrounding community may also deviate from WHO growth
330   standards and it is helpful to see the nutritional status of children in IBC in local as well as global
331   context. Multiple studies found that children in IBC were more undernourished than community
332   children (CC) or children living in family-based care (FBC) (Table 2). Six studies indicated that
333   peers within the community were more likely to be malnourished than children living within
334   IBC, although this varied a bit by age. This could be in part due to children in care receiving
335   adequate nutrition, routine meals and health screenings, especially for children who have HIV
336   and/or it could reflect the challenges faced by families in those communities (Braitstein et al.
337   2013; Panpanich et al. 1999; Sarma et al. 1991; Whetten et al. 2014; Whetten et al. 2009; Zahid
338   & Karim 2013).

339   Clinical signs/symptoms, micronutrient status and infections

340   HIV prevalence was higher than global percentages for the few sites that reported it (The World
341   Bank Group). HIV can be a significant risk factor for becoming malnourished and is also a
342   contributing factor to children ending up in care (Kotler 1989; Leyenaar 2005). Another clear
343   gap was that less than a third reported on the micronutrient status and less than half reported on
344   clinical signs/ symptoms or infections (Table 3). Micronutrient deficiencies were common with a
345   prevalence of anemia higher than the global average in the majority of studies (The World Bank
346   Group). The prevalence of micronutrient deficiencies in children in IBC is likely linked to their
347   increased risk of sickness or morbidities (Black et al. 2013). Hearst et al. concluded that the
348   growth-related indicators coincide with the high prevalence of low albumin, indicating
349   generalized chronic undernutrition and suggests macronutrient deficiencies that could be due to
350   inadequate diets, infections and/or inflammation, or impaired nutrient absorption or utilization
351   secondary to the psychosocial stress of living in an institution (Hearst et al. 2014).

352   Dietary diversity, intake and food security

353   Only eight (32%) studies included information on dietary intake and, of those, half found intake
354   or diet diversity to be inadequate. Dietary diversity was reported to be low for children in IBC,
355   especially in terms of fruits, vegetables and protein. Limited funding and reliance on donations
356   for food were frequently mentioned issues, and resulted in diets high in starches and legumes
357   (Mwaniki et al. 2014). Dietary adequacy varied; in some IBC sites children received an adequate
358   amount or more than recommended dietary allowances and in others they received below the
359   recommendations. Interestingly, the one study which reported on food security found that
360   children in a Kenyan orphanage had higher food security when compared to children in FBC
361   (Braitstein et al. 2013). However, it is impossible to generalize from this one study to say
362   anything more broadly about food security.

363 <u>Limitations</u>

364 We focused on nutritional status of children living in care but note that many other issues (e.g.
365 development, cognition, puberty, catch-up growth, care practices, length of stay, age at
366 admission, cause of institutionalization, illnesses, health of children who have been adopted or
367 cultural practices) affect the demographics, health and well-being of children who are in
368 institutions. It could be that all children coming into care are at risk due to the adverse events and
369 trauma of being abandoned or orphaned (Baron et al. 2001; Martins et al. 2013; The Children's
370 Health Care Collaborative Study Group 1994; The St. Petersburg-USA Orphanage Research
371 Team 2008). These wider factors were beyond the scope of this study (as well as infrequently
372 reported in sufficient details in papers). Given biological links between poor nutrition and sub-
373 optimal child development, evaluating these topics in more depth is critical in future work.

374 Although we found some research, there was limited recent information on this population of
375 children. This may be because of practical or ethical considerations or it may reflect the desire to
376 move away from institution-based care to family-based living situations for children (Kelley et
377 al. 2016). This review also only analyzed data from January 1990 to January 2019 and the
378 studies were of differing designs and types. Other weaknesses included the common use of non-
379 standard reporting methods or lack of clarity around measurement methods, such as how studies
380 assessed micronutrient status or clinical signs and symptoms or determined disability status.
381 Many of the studies were examining other subjects and nutritional/anthropometric information
382 was only supplementary. Furthermore, growth measurements may have been affected by
383 measurement or other errors (e.g. incorrect birthdate estimates leading to incorrect z-score
384 calculations for age-related indices). Additionally, children with some types of disabilities may
385 be shorter or lighter not because of inadequacy of dietary intake but because of their specific
386 underlying conditions (e.g. disabilities such as Down syndrome and many others are associated
387 with non-standard growth and development). The review did not find not enough studies to be
388 able to examine differences between IBC, FBC, CC and CLS (children living on the streets).
389 Another consideration is the potential for healthy survivor bias and sampling bias: some of the
390 most vulnerable children may have died prior to measurement; younger children and healthier
391 children may more quickly leave institutions with the remaining older residents more likely to
392 have deficiencies (Marinus H van IJzendoorn 2011; The St. Petersburg- USA Orphanage
393 Research Team 2005).

394 Risk of bias was apparent in most of the studies. We had originally considered using a formal
395 risk of bias tool to differentiate study quality but did not do so because it became apparent that
396 all of the studies had a high risk of bias and could not be representative of all the institutions in
397 the countries. Another concern was that many used convenience sampling. It is also plausible
398 that the sites included in the research were better-off facilities, which welcomed researchers, who
399 were looking to share positive results and good performance. These are unlikely to be
400 representative of all sites; we speculate that the overall situation is likely worse at many facilities
401 with higher prevalence of malnutrition indicators. There is also wide variation between different
402 institutional care facilities (Marinus H van IJzendoorn 2011; Petrowski et al. 2017; Whetten et al.
403 2014).

404 **Conclusions**

405 A key finding from this study was the limited amount of quality evidence-based data available
406 on the nutritional status of children in institutions. Equally as important, our review found that
407 where data was available, children living in institutionalized care were consistently at high risk
408 of malnutrition, commonly experiencing undernutrition, overweight and/or micronutrient
409 deficiencies. The implications for caregivers, clinicians, institutional administration and policy
410 makers is that work is needed to ensure all children's basic rights to nutrition are met. Children
411 living within care are at risk and require special attention. This is especially true for children
412 with disabilities and low birth weight infants.

413 Although institutionalized care is not the ideal setting for children to grow up in, living within
414 care continues to be a reality for many children. This study is in agreement with other papers and
415 reports that support optimizing current institutional environments when alternative placements
416 for orphaned or abandoned children are not available. These children have a right to good
417 nutrition, both to maintain their health now and to allow them to grow into healthy adults.
418 Interventions will need to be multifaceted to address all of the root causes of malnutrition faced
419 by children living in care. The need for much more evidence as well as a commitment to
420 monitoring and evaluation of nutritional status in all institutions, should be acknowledged and
421 children supported through improved nutrition programming as part of broader policy and child
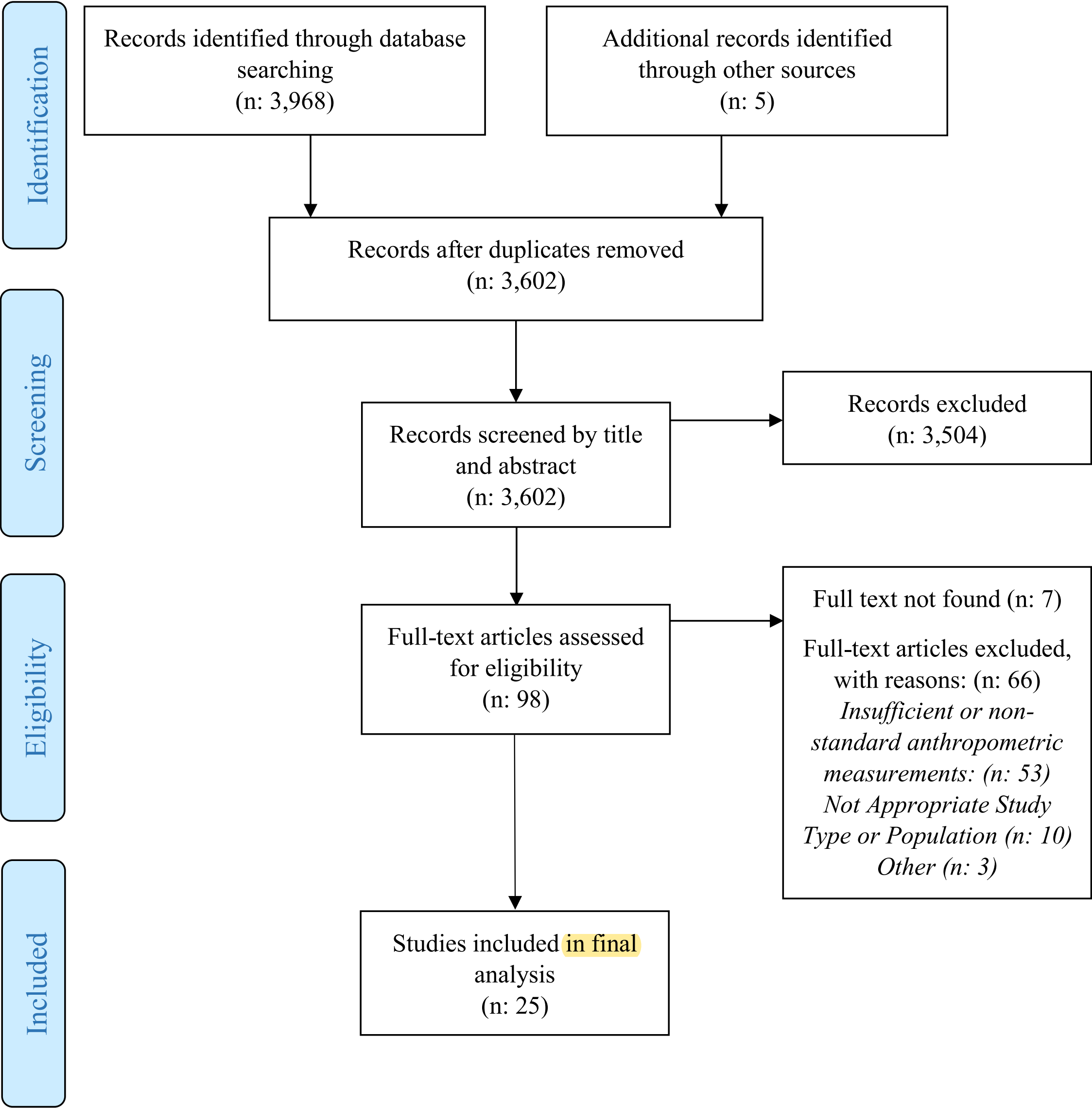422 rights initiatives.

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Table 1(on next page)

PRISMA flow diagram

```
┌──────────────┐   ┌─────────────────────────────────┐   ┌─────────────────────────────────┐
│              │   │ Records identified through      │   │ Additional records identified   │
│ Identification│   │ database searching              │   │ through other sources           │
│              │   │ (n: 3,968)                      │   │ (n: 5)                          │
└──────────────┘   └─────────────────────────────────┘   └─────────────────────────────────┘
```

Records identified through database searching
(n: 3,968)

Additional records identified through other sources
(n: 5)

Identification

Records after duplicates removed
(n: 3,602)

Screening

Records screened by title and abstract
(n: 3,602)

Records excluded
(n: 3,504)

Eligibility

Full-text articles assessed for eligibility
(n: 98)

Full text not found (n: 7)

Full-text articles excluded, with reasons: (n: 66)
Insufficient or non-standard anthropometric measurements: (n: 53)
Not Appropriate Study Type or Population (n: 10)
Other (n: 3)

Included

Studies included in final analysis
(n: 25)

Table 2(on next page)

Description of studies included in review.

Description of studies included in the review of children living within institutionalized care from 0-18 years old.

1

Table 1: Description of studies included in review.
Description of studies included in the review of children living within institutionalized care from 0-18 years old.

Author, Year	Study Design	Country	Number of Institutions	Study Population	Gender (Percent Female)
Multi-Country					
Whetten, 2014	Longitudinal Cohort	Cambodia, Ethiopia, India, Kenya, Tanzania	83	n: 2,283, IBC: 993 (43.5%) and FBC: 1,290 (56.5%), median age 9 years at baseline, range 6–12 years and median age 12 years at year 3 follow-up, range 8–16 years	IBC: 43%, FBC: 47%
Whetten, 2009	Cross Sectional	Cambodia, Ethiopia, India, Kenya, Tanzania	83	n: 2,837, IBC: 1,480, 6-12 years, mean age 9 years, FBC: 1,357	IBC: 42.8%, FBC: 47.1%
Africa					
Aboud, 1991	Cross Sectional	Ethiopia	1	n: 81, 5-14 years, IBC mean age 9.5 years ± 2.8, FBC mean age 9.7 ± 2.6	25.9 %
Braitstein, 2013	Cross Sectional	Kenya	19	n: 2862, IBC: 1337, FBC: 1425, CLS: 100, 0-18 years, median age 11.1 years	46%
Mwaniki, 2014	Cross Sectional	Kenya	4 Schools (many orphanages fed into them)	n: 416, IBC: 208, CC:208, range 4-11 years, 50% 4-7 years and 50% 8-11 years	50%
Panpanich, 1999	Cross Sectional	Malawi	3	n: 293, IBC: 76, mean age 6.44±4.69, range 0-<15 years, FBC: 137, mean age 7.92±2.62, CC: 80, mean age 6.1±3.17	Total: 45.4% , IBC 44.7%, FBC: 44.5% CC: 47.4%
Asia					
bin Shaziman, 2017	Cross Sectional	Malaysia	5	n: 85, 13-18 years	-
Chowdhury, 2017	Cross Sectional	Bangladesh	1	n: 232, 6-18 years, mean age 13.38 years ± 3.69	44%
Hearst, 2014	Cross Sectional	Kazakhstan	10	n: 308 children, 0- 3 years	-
Kapavarapu, 2012	Prospective Longitudinal	India	1	n: 85, mean age 9.2 years, range 4–14	40%
Kroupina, 2014	Cross Sectional	Kazakhstan	6	n: 103, ages 5–29 months, mean 14.89 months±6.85)	49.5%

Lewindon, 1997	Cross Sectional	Hong Kong	1	n: 215, 11.9 years±5.2, range 1.9-27	47%
Myint, 2012	Cross Sectional	Myanmar	1	n: 60, 2-15 years, >5: 26.7%, 5-10: 56.7%, 11-15: 16.6%	53.3%
Sarma, 1999	Cross Sectional	India	70	3,822, 6-18 years	-
Zahid, 2013	Cross Sectional	Bangladesh	1	n: 49, 6-15 years, mean age 8.72 years±1.38	61%
Eastern Europe					
Lesho, 2002	Cross Sectional	Moldova	-	n: 367	-
Miller, 2006	Cross Sectional	Russia	3	n: 234, mean age 21 months±12.6, range 1.5 months to 6 years	45% (gender not recorded for 12 children)
The St. Petersburg— USA Orphanage Research Team, 2005	Cross Sectional	Russia	3	n: 325 children, 0-5 years	-
European Union					
Johnson, 2010	Cross Sectional	Romania	6	n:136, mean age 21 months±7.32; range 5 months- 2.7years	50%
Martins, 2012	Prospective Longitudinal	Portugal	15	n: 49, mean 7.14 months±6.17) range 0–21 months	49%
Pysz, 2015	Cross Sectional	Poland	5	n:153, range 7- 20 years	43.8%
Smyke, 2007	Cross Sectional	Romania	6	n: 208, IBC: 123, CC: 66, 5 months– 2.6 years, mean age 20.65 months±7.26	IBC: 50.4% CC: 53%
Middle East					
El-Kassas, 2017	Cross Sectional	Lebanon	2	n: 153, 5-14 years, mean age 8.86±2.45 years	62.7%
South America					
Nunes, 1999	Cross Sectional	Brazil	1	n: 243, 1-15years	30.3%

The Caribbean					
Nelson, 2016	Cross Sectional	Jamaica	3	n: 226, IBC n: 113, 5-18 years, mean 10.66±3.67 years, CC n: 103, mean 10.28 years±3.20	IBC: 38.9%, CC: 58.3%
Study population: IBC: Institution-based Care; FBC: Family-based Care (orphaned or abandoned children in community Community Children (non-orphans); CLS: Children living on the Street					

2

Table 3(on next page)

Anthropometric measurements and results.

Anthropometric data of children 0-18 years old, living within institutionalized care in various countries.

1

Table 2: Anthropometric measurements and results.
Anthropometric data of children 0-18 years old, living within institutionalized care in various countries.

Author, Year	Growth Reference	Weight for Age (WAZ)	Weight for-Length/Height (WHZ)	Length/Height for Age (HAZ)	BMI-for-Age	Head Circumference for Age	Other
Multi-Country							
Whetten, 2014	WHO growth charts	-	-	IBC: Mean -1.0±1.4, FBC: Mean -1.0±1.3	IBC: Mean -0.7±1.0, FBC: Mean -0.7±1.2	-	-
Whetten, 2009	WHO growth charts	-	-	IBC: Mean -0.96±1.46, FBC: Mean -1.03±1.29, Weighted IBC vs. FBC: Mean (CI) 0.011 (-0.08, 0.10)	IBC: Mean -0.68±0.97, FBC: Mean -0.73±1.39, Weighted IBC vs. FBC: Mean (CI) 0.072 (-0.01, 0.16)	-	-

Africa							
Aboud, 1991	NCHS	IBC: > 80%: 64% < 80%: 36% FBC: > 80%: 73.5% < 80%: 25.6% p = NS	IBC: > 80%: 97.3% < 80%: 2.7% FBC: > 80%: 95.6% < 80%: 4.1% p = NS	IBC: > 90%: 76% < 90%: 24% FBC: > 90%: 91.8% < 90%: 8.2% p < 0.05	-	-	-
Braitstein, 2013	WHO	≤ 10 years, n: 2131 ≥-2 z-scores OR unadjusted IBC: 1 FBC: 0.87 (0.56–1.34)	≤ 5 years, n: 380 ≥-2 z-scores OR unadjusted IBC: 1 FBC: 1.02 (0.55–1.90)	0-18 years, n: 2842 ≥-2 z-scores OR unadjusted IBC: 1 FBC: 2.27 (1.74–2.94) CLS: 4.95 (3.13–7.82) % Stunting IBC: 59% FBC: 74% CLS: 88%	10-18 years, n: 2374 ≥-2 z-scores OR unadjusted IBC: 1 FBC: 0.70 (0.49–1.01) CLS: 0.58 (0.31–1.08) High BMI (p <0.001) IBC: 10% FBC: 16% CLS: 19%	-	-

Mwaniki, 2014	WHO 2006	IBC n: 69 % underweight: 33.2% CC n: 31 % underweight: 14.9% Total n: 100 % underweight: 24% p > 0.0001	IBC n: 19 % wasted: 9.2% CC n: 20 % wasted: 9.7% Total n: 39 % wasted: 9.4% p= 0.866	IBC n: 98 % stunted: 47.2% CC n: 51 % stunted: 24.5% Total n: 149 % stunted: 35.8% p > 0.0001	-	-	-
Panpanich, 1999	NCHS	<5 years Mean z-scores: IBC: -2.17±1.46 FBC: -1.82±1.19 CC: -1.37±1.28 Moderate underweight (<-2 z-scores) %: IBC: 54.8% FBC: 33.3% CC: 30% Severe underweight (<-3 z-scores) %: IBC: 38.7% FBC: 16.7% CC: 6.7% ≥5 years Mean z-scores: IBC: -0.91±0.96 FBC: -1.11±1.10 CC: -	<5 years Mean z-scores: IBC: -0.35±1.15 FBC: -0.68±1.10 CC: -0.45±0.93 Wasting (<-2 z-scores) %: IBC: 9% FBC: 12% CC: 0% ≥5 years Mean z-scores: IBC: -0.08±0.91 FBC: -0.64±0.99 CC: -0.53±0.79 p<0.05 for variance between the three groups Wasting (<-2 z-scores) %: IBC: 0% FBC: 5.3%	< 5 years Mean z-scores: IBC: -2.75±1.29 FBC: -2.20±1.51 CC: -1.61±1.57 p<0.05 for variance between the three groups Stunting (<-2 z-scores) %: IBC: 64.5% FBC: 50% CC: 46.4% ≥5 years Mean z-scores: IBC: -1.07±1.51 FBC: -1.07±1.51 CC: -1.41±1.41 Stunting(<-2 z-scores) %: IBC: 9.1% FBC: 30.4%	-	-	-

		1.24±1.00	CC: 2.3%	CC: 34%			
		Moderate underweight (<-2 z-scores) %: IBC: 6.8% FBC: 23.9% CC: 20.8%					
Asia							
bin Shaziman, 2017	WHO Growth References	-	-	-	Severely thin 4.7% Thin 2.4% Normal 61.2% Overweight 16.5% Obesity 15.3%	-	-
Chowdhury, 2017	WHO Growth References, Essence of Pediatrics 2011 ranges for malnutrition	Total malnourished : 60.3%, Mild: 43.1%, Moderate: 16.8%, Severe: 0.4%	-	-	-	-	-

| Hearst, 2014 | WHO 1996, 2006 | n: 286, mean z-score: -1.3 ± 1.5, median -1.3

31.5% underweight | n: 286, mean z-score: -0.7 ± 1.5, median -0.6

22.1% wasting | n: 286, mean z-score: -1.5 ± 1.9, median -1.5

36.7% stunting | - | - | - |
| Kapavarapu, 2012 | NCHS, CDC, WHO 2006 | 25th percentile: -3.73
Median: -2.75
75th | 25th percentile: -2.29
Median: -1.30
75th | 25th percentile: -3.06
Median: -2.69
75th | - | - | - |

		percentile: -2.05	percentile: -0.56	percentile: -1.94			
		Underweight (WAZ < -2): 79%	Wasting (WHZ < -2): 27%	Stunting (HAZ < -2): 72%			
		Over 36 months median WAZ increased to -1.74, 25th percentile -2.46, 75th percentile-1.03 (P < 0.001).	Median WHZ scores increased to -0.10, 25th percentile -0.18, 75th percentile -0.01 over 36 months (P = 0.49)	Over 36 months Median HAZ also increased to -1.63, 25th percentile -2.19, 75th percentile: -0.77 (P < 0.001).			

Kroupina, 2014	WHO 2006	Mean: -1.34±1.17, range -4.9 to 0.94 <-2 z-scores: 22.3%	Mean: -0.63±1.41, range -4.44 to 2.84 <-2 z-scores: 19.4%	Mean: -1.62±1.61, range -5.49 to 3.11 <-2 z-scores: 35.5%	-	n:102, mean: -1.70±1.27, range -4.53 to 1.90 <-2 z-scores: 41.2%	-
Lewindon, 1997	Not specified n:141	Mean: -3.9 z-scores	-	-	-	-	Triceps Skin Fold Median: 58.6%
Myint, 2012	WHO	-	-	Short Stature: 18.3% Stunted 45%	Underweight: 26.7% Overweight: 8.3% Obese: 1.7%	-	-

Sarma, 1999	NCHS	Girls mean wt range (kg): 16.5±2-46.8±9.66 Boys mean wt range (kg): 16.3±2.18-49.3 ±6.96	-	Girls mean ht range (cm): 104±6.30-154.2±5.64 Boys mean ht range (cm): 106±6.52-166.0±9.49	-	-	Girls mean arm circumference (cm): 15±0.78-22.7±3.59 Boys mean arm circumference (cm): 14.5±1.04-23.3±0.60
Zahid, 2013	Nutrition survey of Rural Bangladesh 1996	Mean: -0.39±1.22 Underweight: 13% Normal: 84.8% Overweight: 2.2%	Mean: -0.38±1.36 Wasted: 2.7% Normal: 83.8%, Overweight: 8.1% Obese: 5.4%	Mean: -0.76±1.02 Stunted: 8.7% Normal: 89.1% Tall: 2.2%	Underweight: 10.87% Normal: 60.87% Overweight: 21.74% Obese: 6.5%	-	-
Eastern Europe							
Miller, 2006	WHO (excluding head circumference which was compared to American standards) n: 201, mean z-scores (excluding CWD)	Birth: -1.34±0.08 Placement: -1.59±0.12 Present: -1.50±0.12	-	Birth: -.62±.14 Placement: -1.45±0.13 Present: -1.48±0.10	-	Birth: -1.55±0.12 Placement: -1.38 ±0.11 Present: -1.20±0.11	-

The St. Petersburg—USA Orphanage Research Team, 2005	CDC, USA Vital Statistics, and standards for the Northwestern Region of the Russian Federation.	Mean: -1.68 (1.39) CC (n:66):-0.06 (1.02) p<0.01 Intake (N=327, 309) Residents (N=236, 216) Russian 10th percentile: 41-67% 25th percentile: 58-78% 50th percentile: 90-97% 75th percentile: 96-98% 90th percentile: 99% CDC 10th percentile: 55-63% 25th percentile: 73-81% 50th	Mean: -0.60 (1.20) CC (n:66): 0.002 (0.99) Intake (N=294, 304) Residents (N=231, 219) Russian 10th percentile: 24% 25th percentile: 49-54% 50th percentile: 93-90% 75th percentile: 97-95% 90th percentile: 100-98% CDC 10th percentile: 29-25% 25th percentile: 49-50% 50th percentile:	Mean: -1.56 (1.37) CC (n:60): 0.06 (0.98) p<0.001 Intake (N=327, 304) Residents (N=237, 218) Russian 10th percentile: 34-54% 25th percentile: 49-73% 50th percentile:91 -95% 75th percentile: 95-98% 90th percentile: 98-99% CDC 10th percentile: 43-61% 25th percentile: 61-77% 50th percentile:	-	Mean: -1.17 (1.33) CC (n:60): 0.17 (0.79) p<0.001 Intake (N=329, 298) Residents (N=238, 197) Russian 10th percentile: 44-53% 25th percentile: 63-74% 50th percentile: 92-96% 75th percentile: 97-99% 90th percentile: 99-100% CDC 10th percentile: 44-46% 25th percentile: 64-68%	Chest Circumference Intake (N=329) Residents (N=237) Russian 10th percentile: 40-43% 25th percentile: 57-63% 50th percentile: 93-92% 75th percentile: 97-96% 90th percentile: 99%

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		percentile: 90-91% 75th percentile: 97% 90th percentile: 99%	93-90% 75th percentile: 97-95% 90th percentile: 100-98%	78-90% 75th percentile: 93-96% 90th percentile: 97-99%		50th percentile: 89-85% 75th percentile: 97-91% 90th percentile: 98-97%	
European Union							
Johnson, 2010	CDC 2000 IBC: n:125, 21.0 months ±7.4 CC: n: 72, 19.3 months ±7.1	IBC: mean −1.23 ±1.08, P≤.001 z-scores ≤ −2: 25%, P≤.001 CC: mean −0.05 ±1.00 z-scores ≤ −2: 0	IBC: −0.67±1.14, P≤.001 z-scores ≤ −2: 16%, P<.01 CC: 0.16±0.96 z-scores ≤ −2: 2%	IBC: mean −0.84±0.86, P≤.001 z-scores ≤ −2: 9%, P<.05 CC: 0.13±0.91 z-scores ≤ −2: 2%	-	IBC: mean −1.10±0.99, P≤.001 z-scores ≤ −2: 17%, P<.01 CC: −0.15±0.86 z-scores ≤ −2: 2%	-

Martins, 2012	WHO 2009, Latent Class Analysis (LCA) Mean, SD	Persistently low (n: 10, 20.4%) Percentile T0 (admission): 1.23±1.60 Percentile T1: 3.91±6.52 Percentile T2: 2.11±3.39 Percentile T3: 4.39±6.07 Deteriorating (n: 12, 24.5%) Percentile T0 (admission): 19.04±28.63 Percentile T1: 20.85±23.25 Percentile T2: 15.48±21.87 Percentile T3: 17.83 (18.47) Improving (n: 16, 32.7%) Percentile T0 (admission): 24.02±26.42 Percentile T1: 27.92±26.82 Percentile T2: 27.42±28.85 Percentile T3: 30.13±23.98 Persistently high (n: 11, 22.5%)	-	Persistently low (n: 18, 36.7%) Percentile T0 (admission): 3.17±4.47 Percentile T1: 4.52±5.24 Percentile T2: 2.32±2.67 Percentile T3: 4.56 ±4.39 Deteriorating (n: 9, 18.4%) Percentile T0 (admission): 44.51±27.02 Percentile T1: 49.52±12.37 Percentile T2: 21.44±9.64 Percentile T3: 23.83±15.70 Improving (n: 14, 28.6%) Percentile T0 (admission): 15.00±10.00 Percentile T1: 18.17±11.54 Percentile T2: 29.14±26.88 Percentile T3: 32.47±12.18 Persistently high (n: 8, 16.3%) Percentile T0	-	Persistently low (n: 11, 22.5%) Percentile T0 (admission): 5.92±6.72 Percentile T1: 6.13±6.35 Percentile T2: 10.05±8.55 Percentile T3: 14.62±13.79 Deteriorating (n: 9, 18.4%) Percentile T0 (admission): 34.43±29.00 Percentile T1: 42.92±29.14 Percentile T2: 37.79±28.21 Percentile T3: 18.02±14.35 Improving (n: 16, 32.7%) Percentile T0 (admission): 40.42±26.75 Percentile	-

		Percentile T0 (admission): 59.45 (32.81) Percentile T1: 55.95 (27.71) Percentile T2: 52.71 (26.30) Percentile T3: 58.06 (28.73)		(admission): 76.41±32.50 Percentile T1: 71.26±29.18 Percentile T2: 72.82±14.49 Percentile T3: 78.42±20.35		T1: 55.36±24.56 Percentile T2: 60.50±12.84 Percentile T3: 66.05±15.10 Persistently high (n: 13, 26.5%) Percentile T0 (admission): 68.93±24.39 Percentile T1: 90.05±8.58 Percentile T2: 89.58±9.33 Percentile T3: 91.18±7.89	
Pysz, 2015	University of Physical Education in Krakow (percentiles)	-	-	-	Thinness or Underweight: 14% boys and 5% girls Normal BMI: 86% boys and 92% girls Overweight or obesity: 6% boys and 6% girls	-	Thickness of the sum of three skin folds i normal ranges: boys 83% and girls 85%

Smyke, 2007	CDC IBC:123 CC: 62	Mean z-scores: IBC: -1.25±1.07 CC: -.06±1.02 p<0.01	Mean z-scores: IBC: -.79±1.03 CC: .002±.99 p<0.001	Mean z-scores: IBC: -.89±.90 CC: .06±.98 p<0.001	-	Mean z-scores: IBC: -.77±.97 FBC: .17±(.79) p<0.001	Size IBC: -.93±.77 FBC:.044±.89) p< 0.001
Middle East							
El-Kassas, 2017	WHO 2009	-	-	Stunting: < 10 years: 11.3% ≥10 years: 16.4% Total: 13.7% p=0.352	Normal: 90.8% Overweight (≥+2SD): 7.2% Obese (≥+3SD): 2% p=0.311	-	-

South America							
Nunes, 1999	NCHS, type classified according to the Seone-Lathan classification	-	-	-	-	-	-
The Caribbean							
Nelson, 2016	WHO	IBC Girls 5-11 years (n: 24): 0.006±0.748 IBC Boys 5-11 years (n: 38): -0.229±1.09 20% of IBC were mildly underweight, and 2.5% were moderately underweight.	-	IBC Girls 5-11 years (n: 24): 0.509±1.21 12-18 years (n: 20): 0.065±0.962 IBC Boys 5-11 years (n: 33): -0.239±1.29 12-18 years (n: 10): 0.991±2.57 15.3% of IBC were	-	-	Mean MUAC IBC Girls 5-11 years (n: 24): 18.08cm±2 0 12-18 years (n: 20) 22.55cm ±2.87 IBC Boys 5-11 years (n: 38): 17.35cm ±3.8 12-18 years

		CC Girls 5-11 years (n: 39): 0.905±1.30 CC Boys 5-11 years (n: 33): 0.252±0.871 7.3% of CC were mildly underweight.		mildly stunted, and 4.5% were moderately stunted. CC Girls 5-11 years (n: 39): 1.065±0.984 12-18 years (n: 21): 0.785±1.17 CC Boys 5-11 years (n: 33): 0.591±0.928 12-18 years (n: 10): -0.044±1.30 4.9% of CC were mildly stunted.			(n:31): 23.21cm ±2.9 CC Girls 5-11 years (n: 39): 19.87cm ±3.6 12-18 years (n: 21) 24.01cm ±2.54 CC Boys 5-11 years (n: 33): 18.17cm± 2.1 12-18 years (n:10): 23.11cm± 3.1 Mean Triceps Skinfold IBC Girls 5-11 years (n: 39): 18.08cm± 2.0 12-18 years (n: 21) 22.55cm± 2.87 IBC Boys 5-11 years (n: 33): 17.35cm± 3.8 12-18 years (n:10): 23.21cm± 2.9 CC Girls 5-11 years (n: 39): 19.87cm± 3.6 12-18 years

							(n: 21) 24.01cm± 2.54 CC Boys 5-11 years (n: 33): 18.17cm± 2.1 12-18 years (n:10): 23.11cm± 3.1
Study population: IBC: Institution-based Care; FBC: Family-based Care (orphaned or abandoned children in community Community Children (non-orphans); CLS: Children living on the Street							
Anthropometric Measurement Method abbreviations: WHO: World Health Organization; NCHS: National Center for Hea CDC: Centers for Disease Control (USA); BMI: Body Mass Index; ht: height, wt: weight; MUAC: Mid-pper Arm Circum							

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Table 4(on next page)

Diet, micronutrient status and signs/ symptoms results.

Diet, micronutrient status and clinical signs/ symptoms of children 0-18 years old living within institutionalized care in various countries.

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Table 3: Diet, micronutrient status and signs/ symptoms results.

Diet, micronutrient status and clinical signs/ symptoms of children 0-18 years old living within institutionalized care in va

Author, Year	Dietary Analysis	Micronutrient Status	Clinical Signs/ Sympton
Multi-Country			
Whetten, 2009	-	-	By caregiver report, inst were also less likely to l diarrhea or fever in the t interview (19.9 vs. 41.2 220.6%, 95% CI [224% on the day of the intervi weighted difference 26. 24%]).
Africa			
Aboud, 1991	-	-	Edema: IBC (4%), FBC Conjunctival Pallor: IBC Xerophthalmia: IBC (15 Goiter: IBC (2.7%), FBC Nutritional problems we more prevalent among I
Braitstein, 2013	Using the Household Food Insecurity Access Scale (HFIAS), 42% of IBC and 2% of FBC reported being food secure. 95% of children in IBC reported an adequate diet compared to 93% of children in FBC and 99% of SLC, (p= 0.009).	-	HIV rates: IBC (2.1%), (1%) (p = 0.001)
Mwaniki, 2014	Using a 24hr diet recall and Nutri Survey program, diets were assessed. A total of 63 and 37 food items were consumed by the CC and IBC respectively. Only 7.2% of IBC consumed more than three food groups compared to 45.2% of CC. 92.9% of IBC and 54.8% of CC consumed less than four food groups (p<0.05). CC had significantly (p<0.05) higher diversity of foods served than IBC. Energy intake: The total mean energy intake among CC was 1,890 Kcal per day and was significantly higher (p<0.05) than that of IBC. The intake of energy by IBC who took lunch was 1,547 Kcal compared to the energy intake of CC who also took the three meals of the day (p<0.05). The mean energy intake of IBC who did not take lunch was less than half of that of CC. IBC who attended school away from the orphanage had two meals (mainly breakfast	-	IBC Diarrhea: 11.5% Cough/ colds: 12.5% Fever: 1.4% Vomiting/skin rashes: 7 FBC Diarrhea: 2.4% (p= 0.01 Cough/colds: 2.9% (p= Fever: 0.5% (p= 0.8) Vomiting/skin rashes: 0 Prevalence of morbidity (p<0.05) higher among CC children and 1.2 tim sick. IBC had significan prevalence of diarrhea a compared to CC. IBC were twice less like critical times compared reported washing hands

	and supper) in a day during school days and three meals during the weekend and did not meet their daily needs compared to CC who always had three meals. IBC had 3.9 times higher risk of consuming inadequate calories compared to CC. Orphanages tend toward exclusive reliance on starches and legumes. Food in orphanages mainly depended on donations.		the day before the interv 78.2% of CC. 49.4% of washed their hands befo also a higher proportion reported washing hands critical times compared (p<0.01). Vaccination a to CC (p<0.05).
Panpanich, 1999	-	-	Illness in past four week IBC: 35% FBC: 37% CC: 51% Undernutrition was pres who had a history of illn compared with 18.8% o no illness (p<0.05). HIV rates: IBC 23% (3/
Asia			
Hearst, 2014	-	The nutritional status, based on blood biomarkers, revealed that 37.1% of the children were anemic, 21.4% had low albumin, 38.1% had low vitamin D, 5.5% were iodine-deficient and 2% had low serum zinc.	-
Kapavarapu, 2012	Dietary intake was compared with the Indian Recommended Dietary Allowance (RDA). A 24-h dietary recall revealed that children <7 years received 75% of the RDA for energy, and older children received 93 to 107% of RDA for energy. All children received adequate (>100% RDA) amounts of both protein and fat.	Hemoglobin (Hb) level was measured using automated blood analyzer. Results indicated that anemia was a prominent manifestation of HIV. Although baseline prevalence of anemia was only 40%, during the study period the cumulative incidence rose to 85%.	75% had infections in th months) of admission in Pulmonary tuberculosis Impetigo: 31% Varicella zoster: 24% Chronic suppurative oti Parotitis: 13% HIV Group Home
Kroupina, 2014	-	Venous blood samples were used for assessment of hemoglobin status. Anemia status was not found to be predictive of development status. "A significant percentage of the children in Kazakh institutions have micronutrient deficiencies; most strikingly, over half the sample was found to be anemic."	-

Lewindon 1997	-	-	Disabled children in lon increased risk for H. pyl were seropositive for H. pediatric patients (<16y compared with 50 contr (p>0.0002). Children wi frequently have excessiv with saliva could be an e transmission of H. plyor
Myint, 2012	-	-	Ocular manifestations: : Systemic comorbidities: Chronic otitis media: 26 Pulmonary tuberculosis HIV Group Home
Sarma, 1999	Dietary intake was compared with the Indian Council of Medical Research's (1984) recommended dietary allowance (RDA). 1,150 children were selected for dietary analysis. Energy intakes fell short compared to the RDA for most children and the deficit was higher in older children when compared to younger children.	Most common nutritional deficiencies encountered: vitamin A (2-8.5%), vitamin B complex and anemia.	Pallor indicating anemia Phyrnoderma: 1.2-6.8% Angular stomatitis: 1-32 Dental mottling: 1-18% Dental decay: 1-22%

Cough, cold, fever, diar skin, eyes and ear/nose/ most common. Deficien were more common in y |
| Zahid, 2013 | Food intake was obtained by 24 hour food-weighing method for seven days. The average food intake were calculated by using the Institute of Nutrition and Food Science. Total food intake was about double the intake of similar children in the 1995-96 nutrition survey. Mean energy (2,270 kcal), protein (65 grams), carbohydrate (335 grams) and fat intake (73 grams). Carbohydrates, protein and fat provide 59%, 12% and 29% of total calories respectively. Protein intake was 65 grams, about 50% higher than the requirement and the 1995-96 nutrition survey of the urban location of the same group. Energy intake was found 20% higher than requirement and about 42% higher compared to 1995-96 nutrition survey.

Average intake of IBC was higher than the national intake and the nutritional status of IBC was also found to be better than the national average by any nutritional criteria. Studies consider this to be potentially | Mean intake calcium 826 mg, iron 31 mg, vitamin A 6,462 IU, carotene 10,508 µg, vitamin B1 1.60 mg, vitamin B2 1.64 mg, niacin 19 mg, vitamin C 111 mg and zinc 10.2 mg.

"Compared to 1995-96 nutrition survey, IBC had significantly higher micronutrient intake." | - |

	attributed to better health and care system prevailing in the orphanage apart provision of high-calorie and protein-rich food and that the nutritional status IBC, who are nutritionally disadvantageous, can be improved through organized feeding and better hygienic conditions.		
Eastern Europe			
Lesho, 2002	-	90% of children had anemia and one-fourth had severe anemia.	76% of children had par infected with three or m Disease frequency: Dermatologic: 17% Respiratory: 5% Genitourinary disorders Ear, nose and throat: 4% Psychiatric: 3%
European Union			
Pysz, 2015	Diets were chemically analyzed using the Kjeldahl method and Soxhlet method and compared to Polish Estimated Average Requirements. Results indicate that daily diets meet about 80% of recommended intake of energy, fat and carbohydrates. The intake of protein with daily diets exceeded EAR value and ranged from 115 to 362% (average 214.2%). It has been also found that the intake of basic nutrients was varied, coefficient variation (CV) ranged from 22.2% to 27.1%. Boys, compared to girls, spent almost twice as much time on physical activity.	-	-
Middle East			

El-Kassas, 2017	Compared to the Dietary Guidelines for American Children and Adolescents 2015 and based on a semi-quantitative food frequency questionnaire, more than half were estimated to have inadequate daily intake of vegetables, fruit, and proteins compared to the recommendation. 94.8% consumed three meals per day. 20.5% of adolescents ($\geq$10 years) reported meals did not satisfy appetite, compared to only 13% of children below 10 years, with no statistical significance between the two groups (p = 0.480). 45.1% of the studied sample revealed consumption of one snack per day; 49% consumed sweet and 19% consumed salty snacks on a regular basis. 82% of both age groups reported regular intake of breakfast. Inadequate protein intake (OR: 0.017, 95% CI: 0.001–0.291) was associated with statistically significant lower odds for being overweight and obese. Conversely, consumption of sweet snacks (OR: 6.492, 95% CI: 1.124–37.512) was associated with significantly higher odds for overweight and obesity.	-	Abnormal Hair Conditio Abnormal Skin Conditio Muscle Wasting: 2.6% (Edema: 0% Bowing of legs or knock 0.622) Abnormal Mucus Meml 0.014) "Physical signs suggesti deficiencies were detect sample."
South America			
Nunes, 1999	-	Anemia: 3%	"High rates of infectious children." HIV: 9.4% Gastroesophageal reflux Parasites: 6% Skin infections: 10% Upper respiratory infect Conjunctivitis: 1.7%
The Caribbean			

Nelson, 2012	Children living in both residential settings listed (1) carbohydrates and starches, (2) meat and (3) fruits and vegetables as the most commonly consumed food items. Significant difference in self-reports of foods consumed most often by CC and IBC ($X2$ (4, N=215) =21.93, P>0.000). CC were more likely than IBC to report meat as most often consumed food. Chi-square analyses revealed no significant differences in self-reports of foods consumed most often by IBC in the three orphanages. No significant differences in the food served at the three orphanages. No difference between physical activity between IBC and CC or between orphanages.	-	-

Study population: IBC: Institution-based Care; FBC: Family-based Care (orphaned or abandoned children in community Community Children (non-orphans); CLS: Children living on the Street

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