

**TITLE**

FOOD SAFETY KNOWLEDGE AND AWARENESS OF FOOD HANDLERS IN SCHOOL FEEDING PROGRAMMES **IN MPUMALANGA, SOUTH AFRICA**

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## 1 ABSTRACT

2 Food handlers working in school feeding programmes can play an important role in the  
3 prevention of outbreaks of foodborne diseases in schools. This research aims to investigate  
4 the food safety knowledge and awareness of food handlers working for the National School  
5 Nutrition Programme (NSNP), Mpumalanga, South Africa. A cross-sectional, quantitative  
6 research method was used and food handlers were interviewed using a structured  
7 questionnaire. A total of 440 food handlers from 147 randomly selected public schools  
8 participated in this survey. The vast majority (98.9%) of the respondents were females of 36  
9 years and older with a high school education. Up to 91.4% of NSNP food preparation  
10 facilities did not have a hazard analysis and critical control points (HACCP) programme in  
11 place and about 93.2% of food handlers did not know about HACCP. Up to 60% of food  
12 handlers did not know the correct procedure for washing a cutting board after it had been  
13 used. In addition, 95.5% of the food handlers had never sanitized utensils and cutting surfaces  
14 after cutting up raw meat. Most food handlers of the NSNP are lacking in knowledge,  
15 awareness and attitude on many important aspects of microbial food safety hazards.

16 **KEY WORDS:** food safety, knowledge, awareness, food handling practices, school feeding  
17 programmes

## 18 HIGHLIGHTS

- 19 • Most food handlers are female high school graduates older than 36 years of age.
- 20 • Most food service facilities do not practice the hazard analysis and critical control  
21 points (HACCP) programme.
- 22 • The vast majority of the NSNP food handlers have no knowledge of HACCP.
- 23 • Food handlers are deficient in their knowledge, awareness and attitude on important  
24 microbial food safety hazards.

25

## 26 1 INTRODUCTION

27 The inadequate food safety knowledge and skills of food handlers can result in unsafe food  
28 handling practices and cross-contamination in food service establishments (McGill et al.,  
29 2015; Rahman et al., 2012). Previous studies have revealed that some food handlers in many  
30 food service establishments often lack basic food safety knowledge when it comes to  
31 temperature control, personal hygiene and the prevention of cross-contamination (Afolaranmi  
32 et al., 2015; Jianu & Chis, 2012; Martins et al., 2012). The urgency of the matter is stressed  
33 by the findings of the World Health Organisation (WHO) that human actions are the leading  
34 cause of food contamination during food preparation in food service establishments as a  
35 result of non-adherence to good hygiene practices (WHO, 2013).

36 Ensuring the safe handling of food in school feeding programmes remains a big challenge in  
37 many countries, considering that many of these school feeding schemes are often regarded as  
38 poverty and hunger alleviation initiatives (Jomaa et al., 2011; WHO/FAO, 2010).

39 Furthermore, the available resources of most schools involved in school feeding programmes  
40 are sometimes inadequate to support the proper implementation of food safety systems (Bas  
41 et al., 2006; Fotopoulos et al., 2011; WFP, 2012). Food safety assurance in food service  
42 establishments depends heavily on the availability of adequate infrastructure, appropriate  
43 management support and commitment, as well as knowledgeable and skilled food handlers  
44 (Rendall-Mkosi et al., 2013).

45 Outbreaks of many foodborne diseases are due to contamination that occurs during food  
46 preparation within food service establishments (Smigic et al., 2016). Cases of food poisoning  
47 are prevalent in schools as a result of cross-contamination during food preparation (Sanlier &  
48 Konaklioglu, 2012). The outbreaks of foodborne diseases in school feeding programmes can  
49 result in life-threatening diseases, huge medical costs and the spread of infection to other  
50 children and staff, thereby leading to disruption of learning in schools (Scharff, 2012).

51 In 2011 in South Africa 2,560 outbreaks of foodborne diseases was reported, of which the  
52 majority (1700) were among learners of primary and secondary schools (Stats SA, 2014). It  
53 should be noted that children with weakened immune systems are more at risk of contracting  
54 food poisoning compared to those who are in good health (Burke et al., 2016). In 2014, three  
55 learners in the Gauteng and Limpopo provinces in South Africa were reported to have died  
56 after consuming contaminated meals provided by the National School Nutrition Programme  
57 (NSNP) (Nzimande, 2014).

58 With the increased number of public schools offering NSNP meals to learners in South  
59 Africa, it is important that relevant food safety and quality assurance measures are put in  
60 place to prevent or reduce the incidence of foodborne diseases in “from farm to fork” food  
61 chains in schools (Asiegbu et al., 2016; Losasso et al., 2012). Areas of lapses can be  
62 identified for redress by studying the food safety knowledge and safe food handling practices  
63 of food handlers in school feeding programmes. Therefore, the objective of this study is to  
64 assess the food safety knowledge and awareness of food handlers in the NSNP in the  
65 Mpumalanga Province, South Africa.

## 66 **2 MATERIALS AND METHODS**

### 67 *2.1 The study area*

68 The study population consisted of NSNP food handlers in various primary and secondary  
69 public schools in the Mpumalanga Province, South Africa. Mpumalanga is one of the nine  
70 provinces in South Africa with close to 7.2% of the South African population (Stats SA,  
71 2012). The province has 1 821 public schools out of which up to 74% offer a food  
72 programme, the NSNP (Department of Basic Education, 2015).

### 73 *2.2. Research design and sampling*

74 A cross-sectional survey was conducted in which questionnaires were utilised to obtain data  
75 from respondents. A total of 440 respondents were randomly selected from a list of 241  
76 public schools that use the NSNP from a list of schools in the province. Respondents were  
77 individuals of 18 years and older, who were involved in the preparation of NSNP meals.

### 78 2.3. Research instrument

79 A questionnaire which consisted of six sections: socio-demographic characteristics, details of  
80 NSNP food service facilities at schools, training information of NSNP food service staff,  
81 microbial food safety hazard knowledge of the staff of the NSNP, food safety awareness of  
82 NSNP food handlers and food safety attitudes of NSNP food service staff, designed  
83 purposefully for this study using information from literature, was used for data collection.  
84 The questionnaire was piloted in ten schools using thirty food handlers and the information  
85 gained was not included in the final sample. After the pilot study, the structure and wording  
86 of the questions were revised. The reliability and validity of the different sections of the  
87 research instrument were determined (Cronbach's  $\alpha$  for the different constructs ranged from  
88 0.689 to 0.821).

### 89 2.4. Data collection

90 Prior to data collection, the permission to conduct the study was obtained from the  
91 Mpumalanga provincial Department of Basic Education and ethics clearance was provided by  
92 the University of South Africa. Data collection was done by means of an interview with  
93 NSNP food handlers after appointments to conduct the interview had been made with  
94 individual school principals. The interviews were conducted on a one-on-one basis and the  
95 questionnaire was filled in either by the respondents themselves or with the assistance of the  
96 principal researcher depending on the respondent's level of literacy. If they were willing to  
97 participate in the study, respondents were asked to sign a consent form to confirm their  
98 voluntary participation as well as their right to withdraw from the study if they so desired.  
99 The questionnaire of each respondent was coded to ensure anonymity and each interview  
100 session lasted about 20 minutes.

### 101 2.5. Statistical analysis

102 The data collected were statistically analysed using SPSS software version 23. Descriptive  
103 statistics were used to summarise the variables of interest, while the Spearman correlation  
104 and analysis of variance (ANOVA) was used to determine the relation between selected  
105 variables. Statistical significance was identified at a 95% confidence level ( $P \leq 0.05$ ).

## 106 3 RESULTS AND DISCUSSIONS

### 107 3.1. Socio-demographic details of respondents

108 The vast majority of the respondents were females (98.9%) who were 36 years and older  
109 (83.7%), had at least attended high school (59.9%) and had been working for the NSNP for at  
110 least a year (63.7%) (Table 1). Women in rural and suburban communities in South Africa,  
111 who are often unemployed (Stats SA, 2013), are usually responsible for cooking meals for  
112 their families (Allen & Sachs, 2007). The fact that most of the respondents were literate was  
113 beneficial for the NSNP, given that it is easy for literate food handlers to improve their food  
114 safety knowledge through training (Bas et al., 2006; Martins et al., 2012; Osaili et al., 2011).  
115 It is likely to be more difficult for food handlers who are not literate to acquire adequate  
116 knowledge and the skill required to deal with microbiological food safety hazards such as

117 temperature control, cross-contamination and personal hygiene (Bas et al., 2006; Ko, 2013;  
118 Sani & Siow, 2014). The fact that the majority of the respondents had been working as food  
119 handlers in their current food preparation facilities for at least a year was good for the NSNP  
120 considering that a longer term of employment provides a base for the continuous  
121 improvement of safe food handling practices, considering that there is a significant positive  
122 correlation between the food safety knowledge of food handlers and their years of working  
123 experience (Farahat et al., 2015; Siow & Sani, 2011).

124 Less than halve of the respondents (46.4%) had had previous food handling experience or  
125 training when they started working in their current NSNP food preparation facilities (Table  
126 1). This can be attributed to the absence of food safety programmes in the curricula of high  
127 schools in South Africa (Department of Basic Education, 2014; Smith & de Zwart, 2010).  
128 The lack of prior training of food handlers translates into less food safety knowledge and  
129 skills (Egan et al., 2007). Education and training programmes which include aspects of safe  
130 food handling are effective tools to increase food safety knowledge and awareness of hygiene  
131 among food handlers prior to employment in food service establishments (Gillespie et al.,  
132 2000; Sani & Siow 2014).

### 133 3.2. Details of National School Nutrition Programme food service facilities at schools

134 A huge majority (98.69) of the respondents indicated that their schools had a menu that  
135 represented what was on offer (Table 2). Having a menu is important because it is one of the  
136 pre-requisite documents required in the planning phase for any food safety management  
137 programme, as it provides guidance on the types of food stuffs to be purchased, storage  
138 requirements, equipment needed, specific steps for preparation as well as the food safety  
139 critical limits such as final cooking temperatures that need to be monitored and verified (Food  
140 and Drug Administration, 2006). The vast majority (98%) of respondents indicated that they  
141 had not previously attended any food safety training courses (Table 2). Newly recruited food  
142 handlers should not work immediately in food service establishments without prior training  
143 or experience in the safe handling of food (Ababio & Lovatt, 2015; Ko, 2013). The  
144 possession of experience in the safe handling of food is an important prerequisite for the  
145 effective implementation of food safety programmes in food service establishments  
146 (Altekruse et al., 1996). Up to 91.4% of respondents indicated that their respective NSNP  
147 food preparation facilities did not have a hazard analysis and critical control points (HACCP)  
148 programme in place (Table 2). It is not acceptable for many schools are not using this  
149 important tool to alleviate the risk of food-borne disease infection to learners (Tomasevic et  
150 al., 2016), considering that it is mandatory for any food handling enterprise to do so in South  
151 Africa (Department of Health, 2003). HACCP is an effective and economically efficient  
152 approach to food safety control and a requisite in the global food supply chain to minimise  
153 the occurrence of negative effects for consumers (Herath & Henson, 2010; Wilcock et al.,  
154 2011).

155 Furthermore, up to 82.7% of respondents indicated that there was no dedicated food safety  
156 assurance personnel in their respective food preparation facilities (Table 2). This is because  
157 the Department of Basic Education often nominates teachers without qualifications or skills

158 in food safety management to manage the NSNP in schools (Department of Basic Education,  
159 2009). The lack of qualified food safety personnel to manage the NSNP could lead to  
160 improper application and monitoring of safe food handling practices (Rendall-Mkosi et al.,  
161 2013) considering that lack of knowledge about HACCP is a barrier to its successful  
162 implementation (Karaman et al., Ova, 2012).

163 Up to 84.5% of respondents indicated that NSNP meals are prepared in a designated kitchen  
164 out of which 52% used a permanent kitchen while 32.7% make use of a temporal kitchen  
165 (Table 2). The fact that a considerable number of schools are not preparing meals in a  
166 designated kitchen constitutes a food safety hazard because the lack of basic food preparation  
167 infrastructure can contribute to the outbreak of foodborne diseases (Kibret & Abera, 2012).  
168 Furthermore, the lack of appropriate infrastructures, equipment and an incorrect layout in  
169 food service establishments have been found to be the most important obstacles in the  
170 implementation of food safety programmes (Department of Health, 2015; Garayoa et al.,  
171 2011; Lockis et al., 2011). Most NSNP food preparation facilities clearly do not meet the  
172 prescribed pre-requisite requirements for the proper implementation of the HACCP  
173 programme which is essential to maintain food safety (Boro et al., 2015). It is reassuring that  
174 the vast majority of NSNP food preparation facilities had big enough food preparation space  
175 (81.6%), clean portable water for food preparation (79.3%) and enough cleaning equipment  
176 (88.9%) (Table 2) because these are important requirements for the implementation of food  
177 safety procedures (Sun, 2005).

### 178 3.3. Food safety training information of National School Nutrition Programme food service 179 staff

180 Up to 69.8% of respondents indicated that in-service training for safe food handling had been  
181 provided to food handlers in their current NSNP food preparation facilities and 67.01% of the  
182 respondents indicated that they received such training at least once every year (Table 3). This  
183 is beneficial because training on the job has been found to significantly improve the safe food  
184 handling practices and attitudes of food handlers compared to those that are untrained  
185 (McIntyre et al., 2013). Food handlers who have never attended any training related to food  
186 safety have been found to possess poor food safety knowledge (Sani & Siow, 2014) and  
187 unsafe food handling skills (Gould et al., 2013; Shinbaum et al., 2016).

188 Even though most of the respondents (71.7%) in the case study had received training on good  
189 personal hygiene, the majority had not received training in chemical storage (77.5%),  
190 purchasing and receiving procedures (73%), a pest control programme (63.3%), equipment  
191 cleaning procedures (64.8%), kitchen operation procedures (65.5%), an equipment care and  
192 maintenance programme (68.7%) and food allergy safety precautions (82.4%) (Table 3). The  
193 in-service food safety training provided for NSNP food handlers is insufficient and should  
194 include procedures to prevent food contamination and the risk of foodborne pathogens. Food  
195 handlers need to be kept updated about the required procedures in maintaining the quality and  
196 safety of the food produced (Kibret & Abera, 2012).

197 3.4. Microbial food safety hazard knowledge of National School Nutrition Programme food  
198 service staff

199 Up to 93.2% of respondents had not heard of HACCP while up to 96.6% indicated they  
200 needed more information and training on HACCP principles (Table 4). As mentioned earlier,  
201 this state of affairs can be attributed to the fact that HACCP training is not part of the  
202 curricula in most primary, secondary and high schools in South Africa (Department of Basic  
203 Education, 2014) as well as to the fact that most of the NSNP food handlers interviewed were  
204 working in a food service establishment for the first time (Cloete et al., 2009). The lack of  
205 HACCP knowledge by food handlers can hamper their ability to implement food safety  
206 measures in food service establishments (Webb & Morancie, 2015). Elsewhere, studies  
207 conducted in Spain (Garayoa et al., 2011) and Malaysia (Sani & Siow, 2014) also uncovered  
208 that the majority of food handlers in some food service establishments were not  
209 knowledgeable about the HACCP system.

210 A considerable number of respondents did not know the following: that an outbreak of  
211 foodborne disease due to Escherichia coli 015:H7 may lead to kidney failure in children  
212 (43.6%), that undercooked chicken and raw eggs could carry food-borne pathogens such as  
213 Salmonella (35.7%), that it was unsafe to use raw eggs as an ingredient in uncooked food and  
214 salads (49.3%), the correct procedure for washing a cutting board after it had been used for  
215 the preparation of raw meat (69.3%), the correct way of handling accidentally thawed meat  
216 (62%), the safest way to cool a large pot of hot soup (32.3%) and the correct duration for  
217 storing ground beef and hamburger patties in the refrigerator (86.4%)(Table 4). The principal  
218 reason for the lack of adequate knowledge on some these food safety hazards by NSNP food  
219 handlers could be the lack of prior training about microbial food safety hazards before they  
220 were recruited (Quinlan, 2013). This should a concern, because NSNP meals are served to  
221 children who could easily contract foodborne diseases due to their weak immune systems  
222 (Scallan et al., 2013). The fact that the majority of respondents did not know the correct  
223 procedure in cleaning a cutting board after it had been used for raw meat preparation means  
224 cross-contamination between is likely to occur between the cutting board and raw or cooked  
225 foods (Bruhn, 2014). NSNP food handlers should be trained the proper procedure for  
226 washing and disinfecting cutting boards so as to eliminate the possibility of transmitting  
227 foodborne pathogens from one food to another (Farahat et al., 2015; Marriot & Gravani,  
228 2006).

229 NSNP food handlers should know that uncontrolled thawed or cooled food products could  
230 easily reach temperatures that are suitable for the multiplication of bacteria to dangerous  
231 levels and hence should be disposed of (Sani & Siow, 2014; Abdul-Mutalib et al., 2012).  
232 Furthermore, NSNP food handlers should know the appropriate duration to store foods,  
233 especially beef hamburger patties in the refrigerator to prevent high level of microbial growth  
234 and in some instances the accumulation of toxins (Bruhn, 2014). This lack of knowledge on  
235 the correct temperature regimes for food storage is not unique to South Africa: Smigic et al.,  
236 2016, in a study conducted in three European countries also found that many food handlers  
237 lack adequate knowledge on temperature regimes during storage.

238 *3.5. Analysis of variance (ANOVA) of microbial food safety hazard knowledge of National*  
 239 *School Nutrition Programme (NSNP) food service staff*

240 The age factor was the only factor to significantly ( $p \leq 0.05$ ) influence whether or not  
 241 respondents had heard of HACCP. The partial cross tabulation result (PCT1) indicates that  
 242 the older the respondent was the more likely it was that they had not heard about HACCP  
 243 while working for the NSNP (Table 5). This could be attributed to a lack of education and  
 244 fewer training opportunities for older respondents compared to younger ones (Webb &  
 245 Morancie, 2015). Furthermore, older NSNP food handlers were less likely to have formal  
 246 qualifications than their younger counterparts because prior to 1994 when South Africa  
 247 became a democracy, access to formal higher education was not readily available to the  
 248 disadvantaged sector of the population (McNair, 2011). Also, older NSNP food handlers are  
 249 more likely to have more family commitments which may be a hindrance in furthering their  
 250 education and training (Sanlier, 2009). Respondents in the different subgroups within  
 251 “duration worked in NSNP” differed significantly ( $p \leq 0.05$ ) in their response to whether or  
 252 not undercooked chicken and raw eggs can transmit *Salmonella*. The partial cross tabulation  
 253 (PCT) analysis (PCT2) indicates that food handlers who are more experienced are more  
 254 aware of the fact that undercooked chicken and raw eggs can transmit *Salmonella* (Table 5).  
 255 This may be due to the fact that NSNP food handlers probably gain safety food handling  
 256 knowledge and skill over time through in-house training (Roberts et al. 2008). It is crucial  
 257 that food handlers are trained on a continuous basis to increase their knowledge and  
 258 awareness of food safety aspects (Sharif et al., 2013).

259 Respondents in the different subgroups within the “level of education” and the “duration food  
 260 handlers have worked in the NSNP” differed significantly ( $p \leq 0.05$ ) in their response to the  
 261 following: pertaining to whether or not it is safe to use raw eggs in recipes that will not be  
 262 cooked, the acceptable way to clean a cutting board or counter after it has been used for  
 263 handling raw meat and the safest way to cool a large pot of hot soup. The PCT analyses  
 264 (PCT3, PCT4, PCT5 and PCT6) indicate that the higher the level of education and the longer  
 265 the term food handlers have worked for the NSNP, the better their food safety knowledge is  
 266 (Table 5). Even though the level of education of food handlers does not automatically  
 267 translate to food safety knowledge (Webb & Morancie, 2015), individuals with higher  
 268 qualifications are more likely to quickly acquire improved attitudes and behaviours towards  
 269 food safety with an increase in knowledge after training (Young et al., 2015), because of their  
 270 relatively high academic aptitude (Blanch & Aluja, 2013).

271 *3.6. Food safety awareness and attitudes of NSNP food handlers*

272 Most of the respondents indicated that they were not doing the following: using gloves  
 273 (97.5%), covering their mouths with masks (97.7%) or wearing chef’s hats (79.1%) when  
 274 touching or distributing food to learners (Table 6). Gloves, when used properly, prevent  
 275 direct contact between bare hands and food and food contact surfaces, thereby reducing  
 276 opportunities for food contamination. However, the use of gloves remains a contentious  
 277 issue. In order to be effective, they must be used correctly and this implies understanding that  
 278 gloves are an extension of one's hands, therefore they are not a substitute for good hand



279 washing practices. Furthermore, gloves can also become a source of contamination through  
280 contact with raw food material and other food contact surfaces if they are not used properly  
281 (Todd et al., 2010). The usage of gloves is not mandatory in many food service  
282 establishments (Tan et al., 2013). However, most of the respondents indicated that they  
283 always washed their hands before (75.9%) and after (97%) touching unwrapped raw foods as  
284 well as before (98.9%) and after (99.5%) touching unwrapped cooked foods (Table 6). This is  
285 an important food safety measure for NSNP food handlers. Given that they have been found  
286 not to wear gloves, it is imperative for them to practice hand washing, considering that it is an  
287 important step in the prevention of cross-contamination in a food service establishment  
288 (Scallan et al., 2013). Improper hand washing practice during the handling of food is one of  
289 the major contributing factors to cross-contamination, which can put consumers of NSNP  
290 foods at risk for various food safety hazards (Bas et al., 2006; Choi et al., 2016). The non-  
291 covering of mouths or hair by food handlers can render them potential sources of food  
292 contamination (Samapundo et al., 2015; Sani & Siow, 2014). The consequence of this  
293 practice could be disastrous for learners as their food could become contaminated by hair  
294 strands or microorganism from the mouths of food handlers, especially those who are sick  
295 with airborne diseases (McLinden et al., 2014; Parra et al., 2014). However, this food safety  
296 concern can be mitigated by effectiveness professional training on personal hygiene practices  
297 (Jianu & Golet, 2014).

298 Almost all the respondents (99.1%) indicated they always checked the use-by date of food  
299 products before using them (Table 6). This is a good food safety practice which enables food  
300 handlers to determine how long to keep food products without compromising safety and  
301 quality (O'Connell et al., 2016). Keeping food products longer than they have been designed  
302 to be stored can lead to degradation and the growth of micro-organisms which can cause  
303 foodborne diseases (Evans & Redmond, 2014).

304 In terms of cleaning and washing attitudes, the vast majority of respondents indicated they  
305 had never done the following: cleaned by washing in hot soapy water and then sanitised meat  
306 cutting surfaces after usage (95.5%), cleaned by washing in hot soapy water and then  
307 sanitised cooking utensils after each use (80.7) (Table 7). This is a rather unfortunate practice  
308 and may be attributed to a general lack of adequate knowledge by food handlers about the  
309 microbial hazard of cross-contamination due to inappropriate food handling practices (Woh  
310 et al., 2016). Food handlers with limited microbial hazard awareness would likely not to  
311 understand why and how to use sanitizers or would not use it all (Crandall et al., 2016).

312 However, over 86% of respondents indicated that they did the following: always washed their  
313 hands before and after the handling of raw and cooked foods, always washed fruits and  
314 vegetables under running water prior to usage, always or most of the time stored raw meat  
315 below ready-to-eat foods in the refrigerator and always or most of the time used older food  
316 products first (Table 7). It is a good practice, for NSNP food handlers to always wash their  
317 hands as well as fruits and vegetables because it is an important step in the prevention of  
318 cross-contamination by foodborne pathogens (Abadias et al., 2012; Lynch et al., 2009). Hand  
319 washing must always precede the washing of food stuffs and utensils so as to avoid cross-  
320 contamination (Rasool Hassan, 2012). The storage of raw meat below ready-to-eat foods in

321 the refrigerator by food handlers is an important step in the prevention of cross-contamination  
322 between raw food and cooked food via liquid dripping from the raw food (Kibret & Abera,  
323 2012). Using older product first, according to the first in first out (FIFO) principle, can aid in  
324 preventing the growth of bacteria in food products because they have been kept in storage too  
325 long (Grunow & Piramuthu, 2013).

326 When it comes to temperature control and storage practices, only a few respondents did the  
327 following: always or most of the times reheated leftovers (26%) and always or most of the  
328 times used a calibrated food thermometer when checking food temperatures (3%) (Table 7).  
329 The vast majority of respondents had never reheated leftover food (food that remained after  
330 lunch had been served). This may be attributed to the usage of power sources such as wood,  
331 coal, gas and even paraffin which are not convenient for keeping food at a high temperature  
332 for a few hours after lunch had been served (Sugru & Lebelo, 2009). Leftover cooked food  
333 should be kept  piping hot above 60 °C or promptly cooled and refrigerated below 5 °C. The  
334 keeping of cooked food at temperatures ranging from 5 °C to 60 °C must be avoided (WHO,  
335 2006). Leftover food can be reheated at temperature above 60 °C to eliminate harmful micro-  
336 organisms before they are served to learners who eat after school before they go home  
337 (Abdul-Mutalib et al., 2012). It is disappointing that only a small proportion of the food  
338 handlers always or most of the time use a calibrated food thermometer to check food  
339 temperatures. It is important to use a thermometer and check the food temperatures in food  
340 service facilities when testing if food has been cooked at the correct temperature to the centre  
341 or as a control mechanism to check that the appropriate temperature to deactivate pathogens  
342 in food that is being cooked has been attained (Addis & Sisay, 2015; Parra et al., 2014). Like  
343 in the case of NSNP food handlers, other authors have reported the non-usage of  
344 thermometers by food handlers in food service establishments in Italy (Buccheri et al., 2007),  
345 in South Africa (Marais et al., 2007) as well as in Malaysia (Abdul-Mutalib et al., 2012; Sani  
346 & Siow, 2014).

### 347 *3.8 Analysis of variance (ANOVA) in food safety attitudes of NSNP food service staff*

348 Respondents in the different subgroups within the “duration food handlers have worked in the  
349 NSNP” differed significantly ( $p \leq 0.05$ ) in their attitudes towards the following: the cleaning  
350 and sanitising of cutting surfaces after the cutting up of raw meat, the washing of fruits and  
351 vegetables thoroughly under running tap water and the usage of the oldest food products first  
352 (first-in-first-out). The partial cross tabulation results (PCT1, PCT2 & PCT3) indicate that the  
353 longer respondents have worked for the NSNP the better their attitude towards the  
354 aforementioned food safety parameters (Table 8). In addition to the “duration food handlers  
355 have worked in the NSNP”, respondents in the different subgroups within the level of  
356 education differ significantly ( $p \leq 0.05$ ) in their attitudes towards the following: storage of  
357 raw meat in the refrigerator below ready-to-eat or cooked foods and the reheating of leftovers  
358 food thoroughly before serving. The partial cross tabulation results (PCT4, PCT5, PCT6 and  
359 PCT 7) indicate that “the higher the level of education” the better the attitude towards the  
360 aforementioned food safety parameters. Furthermore, respondents in the different subgroups  
361 within the level of education differed significantly ( $p \leq 0.05$ ) in their attitudes towards the  
362 usage of a calibrated food thermometer when checking food temperatures. The partial cross

363 tabulation results (PCT 8) indicate that the higher the level of education of respondents the  
364 better their attitude towards the usage of a calibrated food thermometer when checking food  
365 temperatures (Table 8). Overall, it can be seen that the level of education of NSNP food  
366 handlers and the duration food handlers have worked in the NSNP significantly affect the  
367 level of some aspects of microbial food safety hazard knowledge and food safety attitude of  
368 NSNP food handlers (Table 9). Therefore, continuous education and training on food safety  
369 procedures should be provided to the NSNP food handlers to strengthen their food safety  
370 knowledge, improve their attitude and skills in areas where there are lapses in order to  
371 minimise the risk of foodborne disease outbreaks in the NSNP (Al-Shabib et al 2016). The  
372 level of education of food handlers alone does not automatically translate to food safety  
373 knowledge (Webb & Morancie, 2015).

## 374 5. CONCLUSION

375 The majority of the schools offering NSNP meals have got designated and permanent food  
376 preparation facilities with clean portable water supply. The majority of the NSNP food  
377 handlers working in these facilities were female older than 36 years who have attended at  
378 least a high school. Despite their literacy, the majority of them had no previous food handling  
379 or training when they started working for the NSNP. However, most of them have had in-  
380 service at least once a year, mostly on personal hygiene and not on chemical storage,  
381 purchasing and receiving procedures, pest control, equipment cleaning procedures and food  
382 safety allergy procedures.

383 The vast majority of the NSNP food handlers have not heard of HACCP and most of their  
384 NSNP food service facilities have no such programmes in place. Most of these food handlers  
385 did not know the correct procedures for washing a cutting board after it has been used for raw  
386 meat preparation, the correct way of handling accidentally thawed meat and the appropriate  
387 storage duration for storing beef burger patties in the refrigerator. Even though most of NSNP  
388 food handlers lacked the knowledge, awareness and attitude on many important microbial  
389 food safety hazards, those with higher level of education and those with longer duration of  
390 service in the NSNP, are more knowledgeable on food safety hazards. Based on the findings  
391 of this study, we recommend that newly recruited food handlers be trained on food safety  
392 procedures and thereafter be provided with continuous food safety training on various  
393 aspects of microbial food safety hazards. In addition, even though not mandatory in South Africa, the  
394 HACCP program should be implemented in all NSNP food service facilities to enhance food  
395 safety assurance in the NSNP and to be in compliance with regulations relating to the  
396 application of the hazard analysis and critical control point system number (R.908) of the  
397 foodstudds, cosmetics and disinfectants act (Act No. 54 of 1972) of the republic of South  
398 Africa.

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**Highlights**

- Most food handlers are female high school graduates older than 36 years of age.
- Most food service facilities do not practice the hazard analysis and critical control points (HACCP) programme.
- The vast majority of the NSNP food handlers have no knowledge of HACCP.
- Food handlers are deficient in their knowledge, awareness and attitude on important microbial food safety hazards.

1 **List of tables**2 **Table 1**

3 Biographic information of National School Nutrition Programme (NSNP) food service staff  
 4 (N=440).

	<b>Variables</b>	<b>Frequency (%)</b>
Gender	Female	435(98.9)
	Male	5(1.1)
Age	Under 25 years	4(0.9)
	25-35 years	66(15)
	36-45 years	195(44.3)
	46-55 years	138(31.4)
	56-65	29(6.6)
	Over 65 years	6(1.4)
	Missing system	2(0.5)
Level of education	Less than high school	179(40.7)
	High school	258(58.6)
	Some college	1(0.2)
	University of Technology	1(0.2)
	Diploma/ degree	
	Missing system	1(0.2)
How long have you been working as a food handler in your current NSNP food preparation facility?	Less than a year	157(35.7)
	One (1) to two (2) years	101(23)
	More than two (2) years	179(40.7)
	Missing system	3(0.7)
Do you have any previous experience in the food service before your current employment?	Yes	204(46.4)
	No	228(51.8)
	Missing system	8(1.8)

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15 **Table 2**

16 Details of National School Nutrition Programme (NSNP) food service facilities at schools  
 17 (N=440).

Variables		Frequency (%)
Do you have a menu at your school?	Yes	434(98.6)
	No	6(1.4)
Have you attended any food safety training course for which you have been offered a certificate?	Yes	9(2)
	No	431(98)
Are you currently utilising a HACCP programme/monitoring system at your school?	Yes	32 (7.3)
	No	402 (91.4)
	Missing system	6(1.3)
Does your school have designated food safety assurance personnel?	Yes	364(82.7)
	No	76(17.3)
Where is the food prepared?	<u>Permanent</u> kitchen	229(52)
	<u>Temporal</u> kitchen	144(32.7)
	Classroom	24(5.5)
	Outside in the open area	43(9.8)
Is there adequate space for food preparation?	Yes	359(81.6)
	No	81(18.4)
Is there enough <u>clean portable</u> water for food preparation?	Yes	349(79.3)
	No	91(20.7)
Is there adequate space for serving / portioning of cooked food?	Yes	385(87.5)
	No	55(12.5)
Are there enough cleaning <u>equipment (e.g. a broom, a mop, wipes, a sponge, etc) to clean the kitchen?</u>	Yes	391(88.9)
	No	15(3.4)

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28 **Table 3**

29 Training information of National School Nutrition Programme (NSNP) food service staff  
 30 (N=440).

	Variables	Frequency (%)
Has any training about safe food handling been provided to food handlers in your current food preparation facility?	Yes	307(69.8)
	No	130(29.5)
	Missing system	3(0.7)
If yes, how frequently is training provided?	At least <u>once every term</u>	12(2.73)
	At least <u>once every one year</u>	295(67.01)
	At least <u>once every two year</u>	133(30.2)
Have you received training regarding the following?	Personal hygiene	<b>Yes</b> 220(71.7) No 87(28.3)
	Chemical storage	Yes 69(22.5) No 228(77.5)
	Purchasing <u>and receiving</u> procedures	Yes 83(27) No 224(73)
	Pest control programme	Yes 97(31.7) No 194(63.3)
	Equipment cleaning procedures	Yes 108(35.2) No 199(64.8)
	Kitchen operation procedures	Yes 106(34.5) No 201(65.5)
	Equipment <u>care and</u> maintenance programme	Yes 96(31.3) No 211(68.7)
	Food allergy <u>safety</u> <u>precautions</u>	Yes 54(17.6) No 253(82.4)

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41 **Table 4**

42 Microbial food safety hazard knowledge of National School Nutrition Programme (NSNP)  
 43 food service staff (N=440).

Question and answer options		Frequency (%)
Have you ever heard of HACCP?	Yes	30(6.8)
	No	410(93.2)
Do you think you need more information about HACCP and food hygiene training in NSNP?	Yes	425(96.6)
	No	15(3.4)
The presence of <i>E. coli</i> 015:H7 in undercooked hamburgers <u>may result to</u> kidney failure <u>complications</u> in children after an outbreak of disease.	True	<b>248(56.4)</b>
	False	192(43.6)
Undercooked chicken and raw eggs can carry <i>Salmonella</i> , a foodborne pathogen.	True	<b>283(64.3%)</b>
	False	157(35.7)
It is safe to use raw eggs as an ingredient in uncooked food and salad.	True	<b>217(49.3)</b>
	False	223(50.7)
Which of the following is an acceptable way to clean a cutting board after it has been used for raw meat preparation?	Wash with hot soapy water and rinse with water.	220(50)
	Wash with hot soapy water, rinse with <u>a kitchen sanitiser</u> .	<b>135(30.7)</b>
	Wash cutting board <u>using</u> a dishwasher	85(19.3)
You just realised your electricity has been off and the meat, chicken, and fish in your freezer has thawed. What will be the best thing to do to prevent a foodborne disease due to microbial growth?	Throw the items away.	<b>167(38)</b>
	Cook them right away.	272(61.8)
	See how they smell or look before deciding what to do.	1(0.2)
	Immediately re-freeze until solidly frozen, then cook them.	0
What will be the safest way to cool a large pot of hot soup?	Put the soup in clean shallow pans and refrigerate right away.	<b>298(67.7)</b>
	Keep the soup in the cooking pot and refrigerate right away.	68(15.5)
	Put the soup in a clean, deep pot and refrigerate right away.	39(8.9)
	Cool the soup to room temperature on the counter, then refrigerate it.	35(8)
What is the appropriate duration to store ground beef hamburger patties in the refrigerator?	1-2 days	<b>60(13.6)</b>
	3-4 days	160(36.4)
	5-7 days	147(33.4)
	More than a week	72(16.4)

44 **NB: Correct answers have been written in bold**

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48 **Table 5**

49 Analysis of variance (ANOVA) of microbial food safety hazard knowledge of National  
 50 School Nutrition Programme (NSNP) food service staff (N=440).

Food safety hazard knowledge variable	ANOVA between groups (p-value)		
	Age	Level of education	1.5 The duration you have worked in your current food preparation facility
Have you ever heard of HACCP?	0.002 <sup>¥</sup> PCT 1	0.113	0.139
Do you think you need more information about HACCP and food hygiene in the NSNP?	0.093	0.569	0.163
E. coli (a harmful germ) in an undercooked hamburger can cause kidney failure in children.	0.999	0.490	0.422
Undercooked chicken and raw eggs can carry salmonella (a harmful germ).	0.655	0.098	0.002 <sup>¥</sup> PCT 2
It is safe to use raw eggs in recipes that will not be cooked.	0.234	0.016 <sup>¥</sup> PCT 3	0.000 <sup>¥</sup> PCT 4
Is it safe to give an infant a bottle of baby formula that has been out of the refrigerator for more than 2 hours?	0.407	0.104	0.452
Refrigeration eliminates harmful germs in food.	0.379	0.109	0.423
Which is an acceptable way of cleaning a cutting board or counter after it has been used for raw meat?	0.205	0.000 <sup>¥</sup> PCT 5	0.000 <sup>¥</sup> PCT 6
Your electricity went off in your freezer and the meat, chicken, and fish have thawed. What should you do to prevent the growth of microorganisms?	0.258	0.482	0.516
What will be the safest way to cool a large pot of hot soup?	0.115	0.006 <sup>¥</sup> PCT 7	0.039 <sup>¥</sup> PCT 8
What is the appropriate duration for storing beef hamburger patties in the refrigerator?	0.813	0.859	0.317
If you want to keep a prepared meal for two hours, how will you store it?	0.075	0.996	0.859

¥ : Significance at  $p \leq 0.05$ , PCT: Partial Cross Tabulation

PCT 1: Under 25 (No.: 50%), 25-35 years (No.: 89%), 36-45 (No.: 91%), 46-55(No.: 96%), 56-65 (No.: 100%) and over 65 (No.: 100%)

PCT 2: Less than a year (True: 73.2%), one to two years (64.4%), more than two years (57%)

PCT 3: Less than high school (True: 42.5%), high school (True: 53.3%), college (True 100%)

PCT 4: Less than a year (False: 38.2%), one to two years (55.4%) more than two years (58.7%)

PCT 5: Less than high school (Correct response: 13.4%), high school (correct response: 27.1%), college (Correct response: 100%)

PCT 6: Less than a year (False: 33.8%), One to two years (15.8%) More than two years (14.5%)

PCT 7: Less than high school (Correct response: 60.9%), high school (Correct: 72.5%), college (Correct: 90%)

PCT 8: Less than a year (Incorrect response: 75.2%), one to two years (66.3%), more than two years (62%)

51 **Table 6**

52 Food safety awareness of National School Nutrition Programme (NSNP) food service staff  
 53 (N=440).

Questions and answer options	Frequency (%)	
Do you always use gloves when you touch or distribute food to learners?	Yes	11(2.5)
	No	429(97.5)
Do you always wear a mouth mask when you touch or distribute food to learners?	Yes	10(2.3)
	No	430(97.7)
Do you always wear a chef's hat when you touch or distribute food to learners?	Yes	92(20.9)
	No	348(79.1)
Do you always wash your hands before touching unwrapped raw food?	Yes	334(75.9)
	No	106(24.1)
Do you always wash your hands after touching unwrapped raw food?	Yes	427(97)
	No	13(3)
Do you always wash your hands before touching unwrapped cooked food?	Yes	435(98.9)
	No	5(1.1)
Do you always wash your hands after touching unwrapped cooked food?	Yes	438(99.5)
	No	2(0.5)
Do you always check the use-by dates of food products before using them?	Yes	436(99.1)
	No	6(0.9)

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69 **Table 7**

70 Food safety attitudes of National School Nutrition Programme (NSNP) food service staff  
 71 (N=440).

Question	Frequency (%)				
	Always	Most of the time	Sometimes	Never	Missing system
<b>How often do you perform the following at your current work station?</b>					
<b>Cleaning and washing attitudes</b>					
Clean <u>by washing in hot soapy water</u> and then sanitise cutting surfaces after cutting up raw meat.	17(3.9)	2(0.5)	0	420(95.5)	1(0.2)
Clean <u>by washing in hot soapy water</u> and <u>then</u> sanitise cooking utensils after each use or when there is a chance that they might have been contaminated.	33(7.5)	3(0.7)	48(10.9)	355(80.7)	1(0.2)
Wash fruits and vegetables thoroughly under running tap water to remove dirt and other contaminants prior to using them.	361(82)	46(10.5)	9(2)	24(5.5)	0
<b>Storage attitudes</b>					
Cover and correctly label prepared food before storing.	26(5.9)	18(4.1)	366(83.2)	29(6.6)	1(0.2)
Store raw meat in the refrigerator below ready-to-eat or cooked foods.	245(55.7)	183(41.6)	1(0.2)	11(2.5)	
Use the oldest food products first (first-in-first-out).	185(42)	242(55)	2(0.5)	8(1.8)	3(0.7)
<b>Cooking and temperature control</b>					
Reheat leftovers thoroughly before serving.	68(15.5)	46(10.5)	9(2)	355(80.7)	1(0.2)
Use a calibrated food thermometer when checking food temperatures.	8(1.8)	4(0.9)	31(7)	393(89.3)	4(0.9)

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81 **Table 8**

82 Analysis of variance (ANOVA) of food safety attitudes of National School Nutrition  
 83 Programme (NSNP) food service staff (N=440).

	Age	Level of education	1.5 The period you have worked at your current food preparation facility
<b>Cleaning and hygiene practices</b>			
Clean and sanitise cutting surfaces after cutting up raw meat.	0.083	0.754	0.035 <sup>¥ PCT 1</sup>
Clean and sanitise cooking utensils after each use or when there is a chance that they might have been contaminated.	0.243	0.768	0.953
Wash your hands before you prepare food and after handling raw meat or poultry.	0.219	0.088	0.055
Wash fruits and vegetables thoroughly under running tap water to remove dirt and other contaminants.	0.756	0.137	0.038 <sup>¥ PCT 2</sup>
<b>Storage practices</b>			
Cover and correctly label prepared food before storing.	0.111	0.675	0.342
Divide large quantities of food into smaller containers so as to cool them more quickly.	0.978	0.881	0.315
Use the oldest food products first.	0.291	0.384	0.000 <sup>¥ PCT 3</sup>
Store raw meat in the refrigerator below ready-to-eat or cooked foods.	0.141	0.000 <sup>¥ PCT 4</sup>	0.000 <sup>¥ PCT 5</sup>
<b>Temperature control</b>			
Reheat leftovers thoroughly before serving.	0.436	0.003 <sup>¥ PCT 6</sup>	0.000 <sup>¥ PCT 7</sup>
Use a calibrated food thermometer when checking food temperatures.	0.082	0.022 <sup>¥ PCT 8</sup>	0.818
<b>¥: Significance at p&lt;0.05, PCT: Partial Cross Tabulation</b>			
<b>PCT 1:</b> Less than a year (never: 92.3%), one to two years (never: 98%), more than two years (never: 98.5%)			
<b>PCT 2:</b> Less than a year (always: 75.8%), one to two years (always: 82.2%), more than two years (always: 87.7%)			
<b>PCT 3:</b> Less than a year (always: 29.1%), one to two years (always: 41%), more than two years (always 57.4%)			
<b>PCT 4:</b> Less than high school (always or most of the time: 95.5%), high school (always or most of the time: 98.5%), college (always or most of the time: 100%)			
<b>PCT 5:</b> Less than a year (always: 58.4%), one to two years (always: 75.2%), more than two years (always 96.3%)			
<b>PCT 6:</b> Less than high school (always or most of the time: 14.6%), high school (always or most of the time: 31%), College(always or most of the time: 100%)			
<b>PCT 7:</b> Less than a year (always: 9.5%), one to two years (always: 14.9%), more than two years (always 22.9%)			
<b>PCT 8:</b> Less than high school (never: 84.7%), high school (never: 93.8%), college (never: 100%)			

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85 **Table9**

86 Food safety knowledge and attitude variables that are significantly affected by the level of  
 87 education and or the term of employment in the National School Nutrition Programme  
 88 (NSNP) (N = 440).

<b>Food safety variable</b>	<b>Significant effect produced by factor (<math>p \leq 0.05</math>)</b>	
<b>Knowledge of microbial food safety hazard</b>	<b>Level of education</b>	<b>Term of employment in the NSNP</b>
Whether or not they have heard of HACCP.	Edu <sup>^</sup> FSK <sup>^</sup>	NSD
Safety concerns about the usage of raw eggs in recipes that will not be cooked.	Edu <sup>^</sup> FSK <sup>^</sup>	TE <sup>^</sup> FSK <sup>^</sup>
Whether or not undercooked chicken and raw egg can transmit <i>Salmonella</i> .	Edu <sup>^</sup> FSK <sup>^</sup>	TE <sup>^</sup> FSK <sup>^</sup>
The acceptable way to clean a cutting board or counter after it has been used and the safest way to cool a large pot of hot soup.	Edu <sup>^</sup> FSK <sup>^</sup>	TE <sup>^</sup> FSK <sup>^</sup>
<b>Food safety attitude of food handlers</b>		
The cleaning and sanitising of meat cutting surfaces after usage	NSD	TE <sup>^</sup> FSK <sup>^</sup>
The washing of fruits and vegetables thoroughly under running tap water	NSD	TE <sup>^</sup> FSK <sup>^</sup>
The usage of the oldest food products first (first-in-first-out).	NSD	TE <sup>^</sup> FSK <sup>^</sup>
The storage of raw meat in the refrigerator below ready-to-eat or cooked foods	Edu <sup>^</sup> FSK <sup>^</sup>	TE <sup>^</sup> FSK <sup>^</sup>
The reheating of leftover food thoroughly before serving	Edu <sup>^</sup> FSK <sup>^</sup>	TE <sup>^</sup> FSK <sup>^</sup>
Towards the usage of a calibrated food thermometer when checking food temperatures	Edu <sup>^</sup> FSK <sup>^</sup>	NSD

89 NSD: No significant difference at  $p \leq 0.05$ , Edu<sup>^</sup>FSK<sup>^</sup>: The higher the level of education the better the food  
 90 safety knowledge, TE<sup>^</sup>FSK<sup>^</sup>: The longer the term of employment in the NSNSP, the better the food safety  
 91 knowledge.