Consumption patterns of processed cold meat after listeriosis (Listeria Monocytogens) outbreak: A case study of North-West University (NWU) students, Mmabatho Campus, South Africa

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Abstract. The aim of this study was to analyse the effect of a foodborne disease outbreak (Listeria Monocytogens) and factors which affect the consumption patterns of processed cold meat products by students at North-West University, Mmabatho Campus, South Africa. A well-structured questionnaire was used as a data collection instrument, 375 registered students who enrolled for postgraduate and undergraduate studies were randomly selected within two clusters. The sample size was calculated from the total population of 12864 students using RASOFT calculator. Data was captured and analysed using Microsoft Excel and Statistical Package for Social Science (SPSS) version 25 computer software. Probit Regression Model was employed to identify factors influencing consumption patterns of students after the Listeria Monocytogens outbreak. Factors such as gender, residence, allowance (Income), meal preference, regulation of meals time, price of alternatives and academic level were found to be statistically significant and they do influence consumption patterns of processed cold meat by both undergraduate and postgraduate students in North-West University Mmabatho Campus. The study concluded that disease outbreaks (Listeria Monocytogens) do have a negative impact on student’s consumption patterns and switching behaviour. Findings further revealed that disease outbreak led to the majority of students spending more time preparing meals and this may have a negative effect on their academic and/or extramural activities.

Keywords: Processed cold meat, students' consumption patterns, food-borne disease outbreak, factors influencing consumption
1. Introduction

Worldwide, individuals have different consumption patterns which form part of our living and lifestyle in general [1]. Furthermore, disease outbreak is not a new concept especially in agro-food chains whereby the effects can lead to food insecurity or famine [2]. Processed meat products such as ham, bacon, sausages and other deli meats are used in the preparation of the majority of convenient meals because these products have already been prepared for easy and safe consumption and provide a variety of choice to consumers. According to [3], majority of the aforementioned convenient foods are produced through intensive technical processing and there is an increase in demand which is driven by the demand for easy access, affordability, collection, preparation and overall convenience.

Tertiary students are faced with various lifestyle challenges being on campus and away from home. They are faced with a trade-off between academics and a healthy lifestyle due to the "limited" number of hours in a day which often leads to the consumption of takeaways and ready-made meals to try and save time for academic obligations and other activities they might be a part of including church, cultural and sports activities. Processed meat constitutes a great part of these ready-made and take-away meals that students consume, and this is because among other reasons they are relatively cheaper than other meat products. [4] further stated that, as students, it becomes increasingly difficult to keep up with regular meal time, therefore, less time is spent preparing meals than eating them, as a result, convenient meal such as sandwiches, hotdogs, sausages, and bunny chow amongst many others form a perpetual diet of many students. Furthermore, food consumption and preparation by students is influenced by several factors such as food preference, perception of healthy eating, peer influence, lifestyle characteristics, residence type, income/allowance, gender and beliefs among others [5].

The 2017–18 South African listeriosis outbreak in South Africa resulted from contaminated processed meats produced by Enterprise Foods, a subsidiary of Tiger Brands, in Polokwane. As of 12 March 2018, there have been 183 deaths and 973 confirmed infections. It is the world's worst ever listeriosis outbreak [4]. The occurrence and effects of foodborne disease outbreaks on consumers have been studied worldwide. However, fewer studies have outlined the impact of the foodborne disease on students, especially in South African tertiary institutions. Thus the main aim of this study was to analyse the effect of a foodborne disease outbreak (Listeria Monocytogenes) on the consumption patterns of processed cold meat products by students in North West University, Mmabatho South Africa.

2. Materials and Methods

2.1. Study Area

The study was conducted at North-West University Mafikeng Campus, Mmabatho, North-West province of South Africa. The University was formally known as the University of Bophuthatswana prior to democracy and voted by ballot by the people of Mafikeng to have changed to be called the University of North West after the democratic change. In 2004 the merger between Potchefstroom University for Christian Higher Education, University of North West and Sebokeng Campus of Vista took place collaborating and forming the current North-West University with three different campuses. The Mafikeng campus is in Mmabatho Unit 5, it approximately has 12,864 registered students with seven faculties which are the faculty of Natural Science and Agriculture, Faculty of Economic and Management Science, Faculty of Education, Faculty of Humanities, Faculty of Health science, faculty of Theology and the Faculty of Law. The survey and interviews were conducted from the period June-July 2018.

2.2. Population and sample size determination

The population of the study refers to the study of a group of people or individuals taken from the general population of approximately 12,864 who share a common characteristic, such as age, sex, health conditions. This group can be identified for different reasons such as to analyse factors affecting consumption patterns of students after disease outbreak [6]. For the purpose of this study, the population included 12,864 students registered at the North-West University, Mafikeng campus.
Mmabatho, South Africa. [6] state that sampling involves taking a representative selection of the population and using the data collected as reach information. Therefore, for this research, a sample size of 374 registered students taken from the sample population of 12,864 students using the raosoft calculator software was used.

2.3. Methods of data collection
Primary data was used for this research with a well-structured questionnaire. Students were questioned on different aspects based on the study objectives; student’s consumption patterns before listeriosis outbreak, effect of listeriosis on the consumption of processed cold meat by students and the factors which affect student consumption patterns.

2.4. Methods of data analysis
SPSS version 25 computer software was used for analysis and Probit Regression Model for the analysis of factors affecting consumption of processed red meat as the main objective. Frequency counts and percentages were used to summarize the data and socioeconomic characteristics of students. Furthermore, tables and figures were also used to categorise variables which significantly contribute towards change in consumption patens by students.

2.5. Probit model
Factors influencing consumption patterns processed red meat products by students after disease outbreak were estimated using some economic, social and demographic variables of the student’s time frame of response to the outbreak were also be analysed. The Probit Model was used due to the fact that the dependent variable ($Y_i$) is binary with values being yes (1) if consumption was affected and no (0) if consumption of processed cold meat was not affected by the outbreak. The model is stated by equation 1 below:

$$Y_i = \eta + \beta \sum_{i=1}^{10} Z_i + \varepsilon_i$$

Consequently, the Probit regression model can then be predicted as flows equation (2) below:

$$y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p$$

The independent variables ($Z_i$’s) measured the following parameters; whether students eat processed meat or not, regulatory of meal time, resident type, income/allowance, meal preference, gender, academic level, extra-curricular activities, age, religion, price of alternative products and the error term. $\eta, \beta$ are parameters and prior expectations are explained in table 1 below.

| Table 1. Definition of variables |
|---------------------------------|
| **Explanatory variables**       | **Variable name**                        |
| Gender                          | 1 for male, 0 for female                 |
| Religion                        | 1 if religious, 0 if not religious       |
| Age                             | Number of years                          |
| Allowance                       | In Rands                                 |
| Residence                       | (1 for off-campus living, 0 for those living on campus) |
| ACL                             | Academic level (1 for undergrad, 0 for postgraduate) |
| MPL                             | Meal preference (1 for cooked food, 0 for processed cold meats) |
| RMT                             | Regulatory meal time (1 for yes, 0 for no) |
| ECA                             | Extra-curricular activities (1 for yes, 0 for no) |
| PAP                             | Price of Alternative Products influence on consumption (1 for yes, 0 for no) |
| ALI                             | Academic level influence on consumption (1 for yes, 0 for no) |
| RIOC                            | Residence influence on consumption (1 for yes, 0 for no) |
| ECAI                            | Extra-curricular activities influence of consumption (1 for yes, 0 for no) |
3. Results and Discussion

This section discussed the major findings of the study. SPPSS 20 software was used to analyse the collected data. Before the discussion of the findings, the multi-collinearity test was conducted using the Variance Inflation Factor (V.I.F) to ensure that independent variables are not correlated, furthermore, the test for heteroscedasticity was conducted using the Glejser test. Thereafter the significance of socio-demographic characteristics of student's consumption patterns of processed cold meat after the listeriosis outbreak using descriptive statistics and probit model.

3.1. Multi-collinearity test amongst parameters

3.1.1. Variance inflation factor

Variance Inflation Factor (V.I.F) measures the amount of multicollinearity in a set of multiple regression variables. It provides an index that measures how much variance, the square of the estimates standard deviation, of an estimated regression coefficient is increased because of collinearity. According to table 2 below, the mean VIF = 1.44, which is > 10 meaning there is no multicollinearity. Therefore it was concluded that there was little correlation which makes the model unbiased.

### Table 2. Variance inflation factor

| Variable | Variance Inflation Factor | Tolerance |
|----------|---------------------------|-----------|
| Gender   | 1.065                     | 0.939     |
| Age      | 1.882                     | 0.531     |
| Residence| 1.325                     | 0.755     |
| Religion | 1.037                     | 0.965     |
| ACL      | 1.682                     | 0.595     |
| Allowance| 1.433                     | 0.698     |
| MLP      | 1.092                     | 0.915     |
| RMT      | 1.086                     | 0.921     |
| ECA      | 2.315                     | 0.423     |
| PAP      | 1.060                     | 0.944     |
| ALI      | 1.320                     | 0.757     |
| RIROC    | 1.286                     | 0.778     |
| ECAI     | 2.232                     | 0.448     |

Mean VIF = 1.44

Source: IBM SPSS Statistics Viewer (2018)

3.1.2. Test for heteroscedasticity

Heteroscedasticity is used to examine whether there is a difference in the residual variance of the observation period to another period of observation. This study tested for heteroscedasticity the Glejser test in SPSS and the results are shown in table 3 below. Based on output coefficients the obtained value of Sig >0.05, therefore, it can be concluded that there is no heteroscedasticity problem.

### Table 3. Test results output Glejser

| Variables | Unbiased coefficients | Standardized coefficients | T |
|-----------|-----------------------|---------------------------|---|
|           | B         | Std Error | Beta  |     |   |
| Gender    | -0.019    | 0.052     | -0.020 | -0.370 |
| Age       | -0.017    | 0.013     | -0.096 | -1.328 |
| Residence | -0.133    | 0.058     | -0.136 | -2.281 |
| Religion  | 0.420     | 0.245     | 0.092  | 1.75  |
| ACL       | -0.081    | 0.081     | -0.068 | -1.005 |
| Allowance | -3.294E-5 | 0.000     | -0.148 | -2.362 |
| MLP       | 0.108     | 0.65      | 0.091  | 1.657 |
RMT  0.051  0.079  0.045  0.815
ECA  -0.053  0.188  -0.053  -0.667
PAP  -0.108  0.062  -0.031  -0.574
ALI   0.009  0.058   0.009  -0.149
RIOC -0.052  0.081   0.033  -0.900
ECAI  0.034  0.053   0.033  0.418

Source: IBM SPSS Statistics Viewer (2018).

3.1.3. Probit model

The Probit model was used to analyse factors that influence student’s consumption patterns of processed cold meat. The results from the Probit model in Table 4 below shows that, out of 10 variables that were regressed to check their influence on students' consumption patterns of processed cold meat, their variables were not statistically significant at 5 and 10 percent level of significance, and the variables were: Age, Religion and Extracurricular activity enrolment. However, the coefficients for seven parameters were statistically significant at 5 and 10 percent level of significance as shown in table 3 below.

Table 4. Results of the Probit model Analysis on factors affecting students’ consumption of processed cold meat

| Parameter      | Estimate | Std. Error | T   | Significance |
|----------------|----------|------------|-----|--------------|
| Gender         | -.492    | .349       | -1.411 | *            |
| Age            | .021     | .075       | .278 | NS           |
| Religion       | .747     | 1.173      | .637 | NS           |
| Residence      | -.351    | .349       | -1.006 | *            |
| Allowance      | .000     | .000       | -1.650 | *            |
| Meal Preference| .646     | .636       | 1.017 | *            |
| RMT            | -.238    | .419       | -.567 | **           |
| ECA            | .431     | .680       | .633 | NS           |
| PAP            | 2.245    | 3.282      | -1.183 | **           |
| ALI            | .518     | .438       | .231 | *            |
| Intercept      | -2.959   | 3.917      | -.755 | **           |

Chi-Square 161.193  Sig 0.252

Source: Authors computation (2018)
Significance: * at 10% and ** at 5%

3.2. Gender

Table 5. Frequency of consumption and gender

| Gender | Frequency | Consumption after the outbreak | Percentage |
|--------|-----------|-------------------------------|------------|
| Female | 175       | 60                            | 16.9       |
| Male   | 180       | 12                            | 3.4        |
| Total  | 355       | 72                            | 20.3       |

Source: Field Survey with questionnaires (2018).

From table 5 above, the parameter for gender is with a negative sign and statistically significant at 10% level. This implies that gender has a significant influence on the consumption pattern of processed cold meats by students in the study are. Table 5 above further revealed that out of the 175-female sampled 60 female student’s consumptions of processed cold meat continued but it had decreased while the remaining 115 stopped consuming and out of 180 male students sampled only 12 changed their...
consumption pattern. After data collection it was discovered that male students consumed processed cold meat more than female students regardless of the news of the outbreak, this indicated that females where more concerned about food safety than males while males are more concerned about hunger satisfaction and convenience of food than safety and literature of studies similar to this one made the same observation. [7] mentioned that females are more interested in food safety and not hunger satisfaction, which seems to be the opposite for males. It was also discovered that females were more concerned than males over food safety risks [8].

3.3. Residence

Figure 1. Student residential composition
Source: Authors composition (2018)

Figure 1 above revealed that, the different residences that students lived in and 180 sampled students lived on campus residence and out of this 180, 188 changed their consumption of processed cold meat after the news of the outbreak and used their spare time in between classes to cooking so they avoid buying food from cafeteria and other food stalls where most of these meats were sold and they could do this because they did not have to walk or travel to campus as a result they could go back to their residences after class while waiting for the next class and cook while 29% lived off-campus students' accommodation such as communes, student flats and off-campus student accredited accommodation, 16.9% students lived at home with their families reported that they only consume processed cold meat when they are on campus because at home they find proper cooked nutritious food and 3.4% indicated other forms of residence. This observation shows that students’ residence had a significance in the consumption patterns of students. Furthermore, the parameter for the residence was found to be negative and statistically significant at the 10% level (Table 4). Students living off campus choose different food from those students living off-campus. [9] hence the survey carried out discovered that students who lived on campus residence consumed less processed meals after the news of the outbreak. The same cannot be said about students who reside off campus and had to spend most of their days on campus waiting for classes to end before they could go home therefore while waiting they would purchase food at the cafeteria or at the food stalls outside which serve mostly processed cold meat, this observation showed that even after the outbreak because of time and hunger these students would consume what they could quickly eat and proceed with the day’s activities. Students
revealed that when living in students residences they made time and cooked together with their peers while socializing, which increased chances of eating healthier food as compared to convenient food such as processed cold meats [11].

3.4. Meal Preference
Parameter for meal preference is with a positive sign and statistically significant at 10% level (Table 4). Participants where asked what type of meals they prefer between cooked meals and processed cold meats and those who said they preferred cooked meals said so because of various reasons such as health and taste preferences while those who indicated that they preferred processed cold meat said so because of their convenience and taste. Research has shown that the most important factors that influenced food selection are taste, cost, nutrition, convenience and pleasure amongst others [11]. Preference of meals influenced how much of processed cold meat is consumed by the students, it correlates with the level of nutritional knowledge that students had as some felt strongly about nutrition and thus preferred cook meals over processed cold meat simply because of the level of nutrition that they got from home-cooked meals. It was also recorded in previous studies that people who are actively involved with food preparation such as those who love to cook are usually more concerned about food safety and quality [13]. The consumption of processed cold meats by students was changed after the outbreak and as a result student had to resort to alternative sources of food.

3.5. Students allowance (disposable income)

| Income/Allowance | Frequency of processed cold meat Consumption | Percentage |
|------------------|---------------------------------------------|------------|
| R0 – R300        | 45                                          | 13.4%      |
| R350 -R600       | 24                                          | 6.8%       |
| R650- R900       | 33                                          | 9.4%       |
| R950 – R1200     | 29                                          | 8.2%       |
| R1250- R1500     | 152                                         | 42.8%      |
| R1550- R1800     | 20                                          | 5.6%       |
| R1850-R2100      | 16                                          | 4.0%       |
| > R2150          | 26                                          | 9.8%       |

Source: IBM SPSS Statistics viewer (2018).

Parameter for allowance was found to be positive and statistically significant at 10% level (Table 6). This indicates that allowance that students get to influence their consumption of processed cold meat product. Table 4.5.4 showed that 283 of the respondents got < R1550 and made up 80.6% of the sampled respondents, these 283 respondents consumed proceed cold meat 211 times more than those individuals who got > R1550 allowance monthly. This could be because processed cold meats are cheaper as compared to fresh meat and with the limited budget that students live on it becomes more economical to purchase processed cold meat, for example one can consume a 1kg loaf of Palony longer (3-4weeks eating a slice every day) than a 1kg roll of Wors or 1kg beef. This observation also shows that the outbreak did not influence student's consumption of processed cold meat because they did not have enough to change with substitutes, therefore, most of the respondents stated that they only changed brands and not products. [13] observed that it was mostly individuals with high incomes who perceived food safety to be important than individuals from other categories, mostly because high-income earners have the luxury of substituting anything deemed to be hazardous with the next best alternative. The cost of food is among the highest factors influencing the choice of food consumed amongst college students [14].
3.6. Regular Meal Time
Parameter for regulatory meal time is with a negative sign and statistically significant at 5% (see Table 4). This indicates that the regulation of meals has an influence on the type of food consumed by the students. Only 23% of the surveyed students had a regular meal time while 76% of the students said they did not have a regular meal time (refer to Table 7) because of their academic obligations and schedules which were not constant, this resulted in these students grabbing something to eat quickly while going through their day and most of the foods they had at the disposal while busy were take outs with processed cold meat products such as hot dogs, bunny chow and sandwiches. Factors placing students at risk nutritionally are financial risks, skipping meals, snacking and frequently eating fast foods [15] which put students at a higher risk of being diagnosed with *Listeria Monocytogenes* during the outbreak. Factors such as skipping of meals and not having a regular meal time, snacking in-between classes and frequent consumption of fast food are among factors influencing healthy eating among college students [16].

| Variable                  | Sample number | Frequency | Percentage |
|---------------------------|---------------|-----------|------------|
| Meal preference           |               |           |            |
| Cooked meals              | 355           | 75        | 21%        |
| Processed cold meat       | 355           | 280       | 79%        |
| Regular mealtime          |               |           |            |
| Yes                       | 355           | 83        | 23%        |
| No                        | 355           | 272       | 76%        |
| Academic level influence  |               |           |            |
| Yes                       | 355           | 239       | 33%        |
| No                        | 355           | 116       | 67%        |

Source: IBM SPSS Statistics Viewer (2018).

3.7. Price of Alternatives

![Graph of alternative products vs price of processed cold meat](image)

**Figure 2.** Graph of alternative products vs price of processed cold meat

Source: Pick n Pay Supermarket Megacity (May 2018).

Parameter for the price of alternative products is with a positive sign and statistically significant at 5% level (refer to Table 4). There is a positive relationship between the consumption of processed cold meat products and price of alternative products, figure 2 shows the relationship between processed...
cold meat prices and prices of fresh meat, it is evident that the latter is more expensive as compared to the former and the utility thereof also differs, the former provides more utility for long periods (weeks or days) which it can be consumed while fresh meat provides maximum utility for shorter periods in terms of weeks or days it can be consumed. Reported preference for alternative products is determined by food price [14].

3.8. Academic Level Influence (ALI)
Parameter for academic level influence is with a negative sign and statistically significant at 10% level (Table 4). This indicates that the level of the academic year has an influence on the consumption of processed cold meat, only 33% of students surveyed said that their academic level does not influence consumption when asked, this 33% constituted of students in their first year while 67% said that their academic level influences their consumption. When asked why they said their academic level influenced their consumption most of them indicated that as the level went up the workload also did so there is a time difference between the time they had for the first year and the time which they have in their 2nd or 3rd years of study it was also found out that the faculty which they were enrolled in influenced their consumption in terms of time as some students noted that they had practical’s and theoretical work in their courses. It was found that eating and physical activities of University students are presumed to change over their University experience because there are different obligations with the academic levels and these obligations influence students’ consumption /eating behaviour [15]. Reasons that influence food choices amongst college students are lifestyle changes such as academic obligations and convince of food due to lifestyle changes where students are academically pressured and eat a lot of convenient meals such as processed cold meats [17].

3.9. Non Significant Parameters
Findings further revealed that parameter for age, religion, extra-curricular activities and their influence of consumption were statistically insignificant and had no relationship with the consumption of processed cold meats. However, the research conducted by [2] revealed that older respondents tend to perceive food safety as an important factor in consumption and purchasing by consumers. From the study by [2], the parameter for age was statistically significant as it was a determinant in the response to food safety by individuals. [4] supported this view by stating that concerns about food risks tend to increase with age which made age a significant variable in studying public perceptions to food risks.

4. Conclusions and Recommendations
The results obtained from this study showed that there are socio-demographic factors which influence the consumption of processed cold meat by students. From the study parameters such as gender, income, residence, regulatory meal time, meal preferences, price of alternatives and academic level have been identified to influence consumption of processed cold meat before, during and after a disease outbreak while other parameters were redundant and not statistically significant.

The research findings of this study further highlight that, civil society is concerned about food-related diseases and that some individuals still make decisions on food consumption, preparation and purchase which are not deemed healthy and safe. For University students who are considered to be more alert and cautious in this regard the study showed that this is not always the case due to the lifestyles which they lead when away from home and the pressure of having to be independent, they overlook some things.

Department of health and food processing companies should design, formulate and implement special public education programmes with the aim of informing consumers the importance and significance of proper food handlings practices to avoid contamination of food by bacteria and other microbes.

Government and food safety policymakers must try and to at least help consumers understand the information given on food handling practices that must be adopted to ensure on the using simple words or terminologies and help consumers understand at least basic and advanced nutritional aspects of food.
and thus consider food safety and handling important information to practice as daily routines before consumption of a food product.

Policymakers of food safety should work on and try to eliminate reported difficulties that are encountered by consumers in adapting to changes in consumption and purchase of recalled food during an outbreak like being product /brand specific and clear on what can and cannot be consumed by making sure that information regarding the phenomenon is clear, simple and reaches most consumers so that they do not rely on rumours as a lot of confusion was caused by the recall that students also lost faith in other brands due to the value chain process where contamination occurs.

Phenomenon such as food recalls and disease outbreaks not only affect the producer negatively but also affects the lifestyles of consumers. The costs borne by the consumer is a shift in their overall lifestyle due to time and expenses lost from the outbreaks. Consumption is a primary activity which all consumers engage in and thus need to be taken seriously in terms of information dissemination.

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