Research article

Estimated Maximum Daily Intake of Streptomycin Residue in Pork Consumed by Age and Gender Groups in the Philippines

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Received 14 December 2011 Accepted 7 February 2012 (*: Corresponding Author)

Abstract Dietary intake of significant amounts of residues can lead to adverse health effects and the development of antimicrobial resistance in the population. This study was conducted to determine dietary intake of antibiotic drug residues in pork consumed in the Philippines. The specific aim was to estimate maximum daily intake of streptomycin residue ($EMDI_{STC}$) by age and gender groups. Parameters such as maximum residue limits (MRL), 90^{th} percentile food consumption, body weight, age and gender groups were gathered from local and international institutions. A mathematical equation was used to calculate $EMDI_{STC}$ from MRL multiplied by the 90^{th} percentile food consumption and adjusted by body weight. In the present study, the $EMDI_{STC}$ for infants from birth to less than 12 months of age had the highest intake ratio of streptomycin residue followed by children, adolescents and adults where males were significantly higher than females ($p<0.05$). Based on the findings of the present study, it is concluded that streptomycin detected in pork affects infants from birth to less than 12 months that are more likely to consume it and more vulnerable due to physical activity. This is the first attempt to estimate dietary intake of antibiotic residues in the Philippines. Improvement of mathematical models used in this study is proposed to prioritize better models for veterinary drug residues to ensure the safety of food produced from farm to table.

Keywords: dietary intake, pork, antibiotic residue, age-gender group, Philippines

INTRODUCTION

Food needs to be consumed for maintenance of human functions. Food has to be safe for human consumption. Food safety is imperative for the development and maintenance of a healthy population (Titus, 2007). Consequently, health effects and safety aspects of food are important issues for today's consumers. There are increasing public health concerns that drug residues and their metabolites could be found in meat and other foods of animal origin may and cause adverse effects on consumers' health (EFSA, 2007).

Through time livestock production has evolved from small scale to large scale integrative farming (NMIS, 2006). This required the increased use of veterinary drugs. These are used to cure or prevent diseases in animals, to increase feed efficiency or growth rate, and to sedate animals in order to minimize the effect of stress (Botsoglou and Flatouris, 2001; Doyle, 2006). With the widespread use of veterinary drugs in animal production, there is global concern about the consumption of foods of animal origin that may contain residues and their possible adverse effects on human health (Huss et al., 2004). For instance, with the use of antimicrobials in animal production, there is a possibility for the creation of antibiotic-resistant pathogens in animals that may be transferred to man (FSIS, 2000; Doyle, 2006). Boden (2005) cited that drug residues in food are regarded as very important from the public health's point of view. Moreover, there has been concern about carryover of veterinary drug residues in meat, eggs, and milk to people consuming these foods (Botsoglou and Flatouris, 2001; Doyle, 2006). Potential hazards associated with the presence of veterinary drug residues in edible tissues have been reported to cause toxic or allergic reactions, anaphylactic reactions, headache, and severe aplastic anaemia (WHO, 1999; Kelly, 2005).

Thorough literature search revealed no available study on estimated antibiotic drug residues in pork consumed using mathematical equations in the Philippines. With the increase in reports of occurrence of risk of veterinary drug residues in foods of animal origin in the last two decades (Health Canada, 2003a, Sumner et al., 2004), there is a strong need to study dietary intake of veterinary drug residues. To date, there is no local study conducted on the prediction for residual antibiotics in the Philippines. Thus, this study aims to derive an estimated maximum daily intake of streptomycin residues in pork consumed by age and gender groups in the Philippines.

The overall objective of the study is to determine dietary intake of antibiotic drug residues in pork consumed in the Philippines. The specific aim is to estimate maximum daily intake of streptomycin residue by age and gender groups.

METHODOLOGY

The study was conducted using secondary data collected from local and international institutions for estimating EMDI (estimated maximum daily intake). For instance, local data like the report on veterinary drug residue (2003-2008) from National Meat Inspection Service (NMIS), recommendation on Maximum Residue Limit (MRL) published by the Bureau of Aquaculture Fisheries and Product Standard (BAFPS), the report of Food Consumption Survey in 2003 and Recommended Energy and Nutrient Intake in 2002 published by Food and Nutrition Research Institute (FNRI), and the development of antimicrobial resistance from Research Institute for Tropical Medicine (RITM). International data came from Codex Alimentarius Commission (CAC) on amount of antibiotic drug residues, the procedural guidelines on residues of veterinary drugs in food from JECFA, and from an updated report of the 32nd session of the Codex Veterinary Drug Residues in Food 2009.

EMDI modelling combines MRL data with 90th percentile food consumption data and body weight factor to estimate EMDI. The basic EMDI model is of the form:

$$\text{EMDI} = [\text{MRL X } 90^{th} \text{ percentile food consumption}] \div \text{weight factor}$$

where EMDI is an estimate of drug residue intake expressed in μg/kg BW/day.

RESULTS

Streptomycin is active against a wide range of gram-negative organisms and some gram-positive pathogens in pigs, cattle and sheep. Streptomycin was evaluated by the Codex Committee at its 12th meeting in 1969, 43rd meeting in November 1994, 48th meeting in 1998, report of the 11th session of the Codex Committee on residues of veterinary drugs in food in September 1998 and updated as of the 32nd session of the Codex Alimentarius Commission in July 2009. The committee proposed a temporary MRL's for streptomycin at 600 μg/kg (muscle, liver, fat).

The reference weight for adults, 59 kg for males and 51 kg for females, and the average weight in the Philippines, 55 kg (FNRI, 2003) as well as the 90th percentile food consumption per capita in the Philippines and three islands are shown in Table 1.

Table 1 Mean one-day per capita pork consumption (gram, raw, as purchased) 2003 food consumption survey

	Philippines	Luzon	Visayas	Mindanao
Fresh Meat				
Pork				
Mean	31.80	39.89	23.07	18.24
95% Cl	31.76, 31.83	39.84, 39.93	23.01, 23.14	18.19, 18.30
P90	108.21	127.31	88.50	57.29

Source: FNRI, 2003

However, the weight difference between age groups: infants, adolescents, adults and older; the 90th percentile food consumption per capita; and average weights in the Philippines were calculated using Eq. (1) below.

The 90th percentile food consumption difference age groups = [average weight difference age groups × the 90th percentile food consumption per capita in the Philippines] ÷ average weights in the Philippines (1)

Using Eq. (1), the 90th percentile food consumption different age groups was calculated separately by ages (infants, children, adolescents, and adults), gender, average weights in different age groups, and average weight in the Philippines. A summary for computation of the 90th percentile food consumption in the Philippines is shown in Table 2.

Table 2 Summary of 90th percentile pork consumption per capita by age group and average weight in the Philippines, Luzon, Visayas and Mindanao

Age Groups		Weight (kg)	Philippines (g)	Luzon (g)	Visayas (g)	Mindanao (g)
1. Infants, mo						
	Birth- <6 (3)	6	12	14	10	6
	6-<12 (9)	9	18	21	15	9
2. Children, y						
	1-3 (2.5)	1	26	30	21	13
	4-6 (5.5)	19	37	44	31	20
	7-9 (8.5)	24	47	55	39	25
3. Adolescents, males, y						
	10-12 (11.5)	34	67	79	55	35
	13-15 (14.5)	50	98	115	81	52
	16-18 (17.5)	58	114	134	94	60
4. Adolescents, females, y						
	10-12 (11.5)	35	69	81	57	36
	13-15 (14.5)	49	96	113	79	51
	16-18 (17.5)	50	98	115	81	52
5. Adults, males, y						
	19-49	59	116	136	95	61
	50-64	59	116	136	95	61
	65 and over	59	116	136	95	61
6. Adults, females, y						
	19-49	51	100	118	83	53
	50-64	51	100	118	83	53
	65 and over	51	100	118	83	53

Eq. (2) was used to calculate the EMDI of streptomycin residues by adaptation from the value of Eq. (1) then multipled by MRL muscle tissue and adjusted by weight factor as recommended by

Codex committee and Philippines National Standard. Then comparison of estimates of streptomycin residues intake was computed.

$EMDI_{STC}$= [MRL × the 90th percentile food consumption difference age groups] ÷ average weights differences age groups (2)

Table 3 summarizes the EMDI of streptomycin residue for all locations. Particulars for the computation of EMDI of streptomycin residue in the Philippines, Luzon, Visayas and Mindanao are shown in Appendix B Tables 2 to 5 (Venn et al., 2010).

Table 3 Summary of EMDI of streptomycin residue intake of fresh pork in the Philippines, Luzon, Visayas and Mindanao

Age Groups		Philippines (μg/kg BW/day)	Luzon (μg/kg BW/day)	Visayas (μg/kg BW/day)	Mindanao (μg/kg BW/day)
Infants, mo					
	Birth- <6 (3)	1.2000	1.4000	1.0000	0.6000
	6-<12 (9)	1.2000	1.4000	1.0000	0.6000
	Average	*1.2000*	*1.4000*	*1.0000*	*0.6000*
Children, y					
	1-3 (2.5)	1.2000	1.3846	0.9692	0.6000
	4-6 (5.5)	1.1684	1.3894	0.9789	0.6315
	7-9 (8.5)	1.1750	1.3750	0.9750	0.6250
	Average	*1.1811*	*1.3830*	*0.9743*	*0.6188*
Adolescents, Males, y					
	10-12 (11.5)	1.1823	1.3941	0.9705	0.6176
	13-15 (14.5)	1.1760	1.3800	0.9720	0.6240
	16-18 (17.5)	1.1793	1.3862	0.9724	0.6206
Adolescents, Females, y					
	10-12 (11.5)	1.1828	1.3885	0.9771	0.6171
	13-15 (14.5)	1.1755	1.3836	0.9673	0.6244
	16-18 (17.5)	1.1760	1.3800	0.9720	0.6240
	Average	*1.1786*	*1.1854*	*0.9718*	*0.6212*
Adults, males, y					
	19-49				
	50-64	1.1796	1.3830	0.9661	0.6203
	65 and over	1.1796	1.3830	0.9661	0.6203
		1.1796	1.3830	0.9661	0.6203
Adults, females, y					
	19-49	1.1764	1.3882	0.9764	0.6235
	50-64	1.1764	1.3882	0.9764	0.6235
	65 and over	1.1764	1.3882	0.9764	0.6235
	Average	*1.1780*	*1.1856*	*0.9712*	*0.6219*

Fig. 1 shows that EMDI of streptomycin residues for infants is 1.2 μg/kg BW/day from birth to less than 12 months of age. 1.2 μg/kg BW/day was calculated as 600 μg/kg of MRL multiplied by 90th percentile food consumption infant of 0.012 kg divided by the average weight of infant at 6 kg. It is equivalent to children from one to three years of age. In general, infants had consumed more streptomycin residues than children (1.1811 μg/kg BW/day) followed by adolescents (1.1786 μg/kg BW/day) and adults (1.1780μg/kg BW/day). Moreover, EMDI for males was significantly higher than that for females ($p<0.05$).

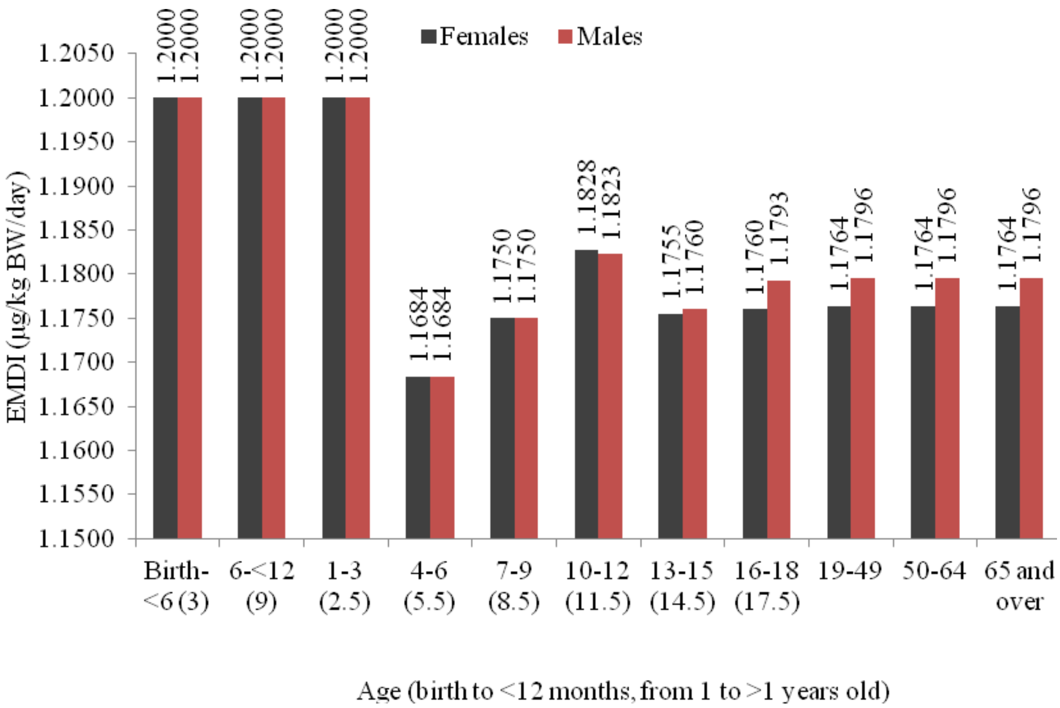

Fig. 1 Estimated maximum daily intake of streptomycin residue for females and males from different age and weight groups in the Philippines

DISCUSSION

Prediction of EMDI of streptomycin residues from dietary intake of pork using a stepwise approach is a step forward to provide an estimate potential exposure of the population. Hence, analysis of EMDI found that infants from birth to less than 12 months of age had the highest intake of streptomycin residue in the Philippines, followed by children, adolescents and adults.

A similar study on the exposure assessment of chemical from packaging materials in food by Pocas and Hogg (2007) mentioned that food consumption by infants and small children is much higher, based on the body weight, than by conventional adult model of 1 kg_{food}/60 kg BW. In addition, infants and children, because of their higher food consumption rates per kg BW, were generally expected to have a higher dietary daily intake of substances (Kroes et al., 2002). However, the assessment on dietary Melamine exposure, Xu et al. (2009) reported that infants of three months old had the highest intake estimate of melamine and with the increase in age, the intake decreased. Another example was conducted on dietary exposure to copper in the European Union. Steve (2008) reported that in most studies in EU member states, age and sex differences were more apparent than regional differences. Young and middle-aged adults have higher mean intake than elderly or very elderly.

CONCLUSION

Based on findings of the present study, streptomycin residue have been detected in pork which infants from birth to less than 12 months are more exposed to and more at risk, because of their higher food consumption rates per kg of body weight, and they are generally expected to have a higher exposure level due to physical activity.

ACKNOWLEDGMENTS

First, my thanks go to Veterinary Drug Residue Section of NMIS, Quezon City Philippines for allow using the new report of veterinary drug residue monitoring program and laboratory technicians of this study. I am thankful to Antimicrobial Resistance Surveillance Program Team of RITM and National Epidemiology Centre, Muntinlupa City, Philippines. I also wish to thank Food of Nutrition Research Institute Team, who has given the 2003 food consumption survey and percentile data released of fresh pork in the Philippines and RENI-FNRI-DOST, Metro Manila, Philippines.

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