4. RESULTS

4.1 *Salmonella* isolation

A total of 262 samples of chicken meat from 62 shops in 16 markets in 5 districts of Hanoi were collected for *Salmonella* isolation. Of these samples, 128 were positive for *Salmonella* giving an overall sample prevalence of 48.9% (Table 7). Seasonally, 41.43% of the samples gathered during winter were positive while 51.56% of spring samples were positive for *Salmonella*. However, these two seasonal proportions were not significantly ($p = 0.1894$) different.

Numerically, the percent of district-specific *Salmonella* contamination was different with the highest recorded in district 2 (62.5%) and the lowest in district 4 (37.5%). No statistically significant difference was observed among proportions ($p=0.0698$) (Table 7).

Similarly, the different markets had different *Salmonella* percent contamination levels. The highest proportion (81.2%) was recorded in Market 2 (M2) located in District 2 (D2) and the lowest (30%) in Market 4 (M4) in District 1 (D1). Nevertheless, there was no significant difference among the proportions of *Salmonella* contamination among and within markets in each district (Table 7).

Table 7: Proportion of *Salmonella* positive sample

Prevalence of *Salmonella* contaminated			**n**	**No. of positive**	**Percent**	**P-value**
Overall			262	128	48.9	
By season						
- Winter time			70	29	41.43	**p=0.1894**
- Spring time			192	99	51.56	
By districts (n=5)						
- D1			70	29	41.42	
- **D2**			48	30	**62.5**	**p=0.0698**
- D3			48	27	56.25	
- **D4**			48	18	**37.5**	
- D5			48	24	50	
By markets in district	**D1**	M1	20	10	50	**p=0.7584**
		M2	20	8	40	
		M3	20	8	40	
		M4	10	3	**30**	
	D2	M1	16	10	61.2	**p=0.0907**
		M2	16	13	**81.2**	
		M3	16	7	43.7	
	D3	M1	16	11	68.7	**p=0.4667**
		M2	16	8	50	
		M3	16	8	50	
	D4	M1	16	6	37.5	**p=0.7659**
		M2	16	7	43.7	
		M3	16	5	31.2	
	D5	M1	16	8	50	**p=0.7788**
		M2	16	9	56.2	
		M3	16	7	43.75	

(D= District; M= Market)

Of the 62 shops participating in the study, there was one shop with 100% percent *Salmonella* contamination (D2 M2 S1) and one shop with no *Salmonella* contamination (D4 M3 S1) (Table 8).

Table 8: Proportion of *Salmonella* positive samples by shop

Market	**Shop**	**District**				
		D1**	D2*	D3*	D4*	D5*
M1	S1	40	75	75	25	50
	S2	40	75	50	50	50
	S3	60	50	75	25	50
	S4	60	50	75	50	50
M2	S1	40	**100**	50	50	50
	S2	60	75	75	25	50
	S3	40	75	50	75	50
	S4	20	75	25	25	75
M3	S1	20	25	50	**0**	25
	S2	80	50	50	50	50
	S3	40	25	25	25	25
	S4	20	75	75	50	50
M4	S1	40	-	-	-	-
	S2	20				

D= District; M= Market; S= Shop

* 4 samples per shop

** 5 samples per shop

4.2 Serogroups and serotypes

A total of 128 *Salmonella* positive samples were tested for sero-grouping using polyvalent antisera I and II. Out of these samples 129 isolates (Table 9) were obtained (2 isolates from sample 44- D2M1S2). All the 129 *Salmonella* isolates belonged to 5 somatic groups. The main somatic groups were B (42.6%), C (27.9%) and E (25.6%).

Table 9: Serogroups of *Salmonella* isolated from chicken meat

Group	No. of isolates in group	Percent (%)
Group B	55	42.6
Group C	36	27.9
Group E	33	25.6
Group D	2	1.6
Group F-67	3	2.3
Total	**129**	**100**

Table 10 shows that members of *Salmonella* group B were most frequently found in the Districts 1, 4 and 5 in the following descending order: 100% in D4, 58.33% in D5 and 48.28% in D1. *Salmonella* group B was found in all markets in D1, D4 and D5. In particular, this serogroup accounts for the majority of isolates that were isolated from all markets of District 4 (100%), following by Market 4 (D1) and Market 2 (D5) with 66.7%

Whereas the most commonly found isolates in D2 and D3 were *Salmonella* Group C (54.84%) and E (48.14%), respectively. Within D2, *Salmonella* group C was found with the highest percentage of 71.44% of isolates from M3. Similarly, in D3, *Salmonella* group E accounts for 75% of isolates from M2.

Table 10: *Salmonella* serogroups distributed by market and district

Districts	Markets	Group B		Group C		Group E		Group D		Polyvalent II		Total
		n	%	n	%	n	%	n	%	n	%	
D1	M1	3	30	3	30	4	40					10
	M2	4	50	3	37.5	1	12.5					8
	M3	5	62.5	2	25	1	12.5					8
	M4	2	66.7			1	33.33					3
	Σ	**14**	**48.28**	**8**	**27.8**	**7**	**24.14**					**29**
D2	M1	2	18.18	5	45.45	3	27.27			1	9.09	11
	M2			7	53.85	6	46.15					13
	M3	1	14.28	5	71.44	1	14.28					7
	Σ	**3**	**9.67**	**17**	**54.84**	**11**	**35.48**					**31**
D3	M1	1	9.09	5	45.45	5	45.45					11
	M2			1	12.5	6	75	1	12,5			8
	M3	5	62.5			2	25	1	12,5			8
	Σ	**6**	**22.22**	**6**	**22.22**	**13**	**48.14**	**2**	**7.41**			**27**
D4	M1	6	33.3									6
	M2	7	38.9									7
	M3	5	27.8									5
	Σ	**18**	**100**									**18**
D5	M1	5	62.5	2	25	1	12.5					8
	M2	6	66.67	1	11.11	1	11.11			1	11.11	9
	M3	3	42.86	2	28.56	1	14.28			1	14.28	7
	Σ	**14**	**58.33**	**5**	**20.83**	**3**	**12.5**			**2**	**8.33**	**24**

Most (67.74%) of the shops were contaminated with *Salmonella* of Group B (Table 11). However, only 3.22% of the shops were contaminated with S*almonella* belonging to Group D and 4.84% shops had *Salmonella* of Group F-67. As the table shows, 40.31% shops were contaminated with two serogroups of *Salmonella* and 8.06% with three serogroups.

Table 11: Distribution of *Salmonella* serogroups by shops (n=62)

Serogroups	Number of shops/ sero-group	Percent
Group B	42	67.74
Group C	26	40.625
Group E	24	38.7
Group D	2	3.22
Group F-67	3	4.84
Two groups		
Overall	**25**	**40.31**
B + E	7	11.29
B + C	7	11.29
C + E	8	12.9
C + F-67	1	1.61
E + D	2	3.23
Three groups		
Overall	**5**	**8.06**
B + C + E	3	4.84
B + E + F-67	1	1.61
B + C + F-67	1	1.61

Table 12 shows the distributions of the numbers of isolates of each *Salmonella* serotype by district and market. Overall, twelve serotypes were identified from 129 isolates. Most (31.01%) isolates were *S.* Agona, followed by *S.* London (18.6%) and *S.* Emek (17.83%). Other serotypes of *Salmonella* detected belong to *S.* Typhimurium (7.75%), *S.* Brunei (6.2%), *S.* Senftenberg (3.87%), *S.* Derby (3.87%), *S.* Weltevreden (3.1%), *S.* Haardt (3.1%), somatic group F-67 (2.33%), *S.* Enteritidis (1.55%), and *S.* Newport (0.78%).

There was only one serotype distributed in District 4 (*S.* Agona), whereas eight serotypes were distributed on District 5. *S.* Enteritidis (two isolates) and *S.* Typhimurium (10 isolates) were found only in D3 and D1, respectively.

S. Agona was found in all markets of D4 and D5. *S.* London was detected in all markets of D2 and D3. *S.* Emek was found in all markets of D2. However, these serotypes were not found in D1.

Similarly, *S.* Typhimurium and *S.* Senftenberg were found in all markets of D1 only (in the winter time), and are meanwhile not found in other districts (in the spring time). In addition, the *S.* Newport serotype was detected only in M1 of D5.

Table 12: Number of isolates in each serotype of *Salmonella* by Markets and Districts

SEROTYPES	Group	D1				D2			D3			D4			D5			Total	Percent
		M1	M2	M3	M4	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	n	%
S. Agona	B					2		1	1		5	6	7	5	5	6	2	**40**	**31.01**
S. London	E					3	6	1	5	6	1				1	1		**24**	**18.6**
S. Emek	C					5	5	4	5	1					1		2	**23**	**17.83**
S. Typhimurium	B	3	2	4	1													**10**	**7.75**
S. Brunei	C	3	3	2														**8**	**6.2**
S. Senftenberg	E	2	1	1	1													**5**	**3.87**
S. Derby	B		2	1	1												1	**5**	**3.87**
S. Wetevreden	E	2									1						1	**4**	**3.1**
S. Haardt	C						2	1								1		**4**	**3.1**
S. F-67	F-67					1										1	1	**3**	**2.33**
S. Enteritidis	D									1	1							**2**	**1.55**
S. Newport	C														1			**1**	**0.78**
No. of serotypes		**4**	**4**	**4**	**3**	**4**	**3**	**4**	**3**	**3**	**4**	**1**	**1**	**1**	**4**	**4**	**5**		**100**
No. of isolates		**10**	**8**	**8**	**3**	**11**	**13**	**7**	**11**	**8**	**8**	**6**	**7**	**5**	**8**	**9**	**7**	**129**	

D= District; M= Market;

4.3 Results from the questionnaire

4.3.1 Shop level

The distributions of proportions of *Salmonella* contaminations per levels of each risk factor and number of shops are shown in Table 13. Eight of 13 factors were significantly associated with *Salmonella* proportions in the univariated analysis.

Summary results of the multiple linear regression analysis are shown in Table 14. The results indicate that “number of knives used” was marginally (p= 0.0632) associated with *Salmonella* contamination.

However, it should be noted that the number of shops which used only one knife were twice the number of shops that used more than one knife (table 13). But the mean prevalence was higher (53.3) than those (40.75) that used more than one knife. These two mean proportions were significant (p=0.0235) at the univariate analytical level.

In addition, the proportion of *Salmonella* contamination in shop was significantly (p<0.0001) associated with the level of “The hygiene status of shop”, whether the shop hygiene level is clean or dirty.

Table 13: Summary results of univariate analysis of potential risk factors for *Salmonella* contamination in chicken shops (continuous variable)

Factors	Level	No. of shop	Mean of proportion	P-value
Chicken/source	Household	55	47.818	0.12037
	Farm	7	60.714	
Chicken/slaughter by	Others	18	50.833	0.7069
	Retailer	44	48.636	
Chicken/eviscerated	at home	46	49.782	0.8293
	at retail	16	47.8125	
Water/source	Well	21	59.048	0.0482
	Tap	41	44.268	
Water/chlorinate	No	21	57.857	0.0178
	Yes	41	44.878	
Water/storage	Closed	2	62.5	0.3612
	Open	60	48.833	
Shop/knife	>1	20	40.75	0.0235
	=1	42	53.333	
Shop/chopper	>1	17	36.765	0.0026
	=1	45	54	
Shop/worker	>1	27	44.63	0.1205
	=1	35	52.857	
Shop/surface	Ceramic	3	26.666	0.0142
	Stainless	40	46.125	
	Steel	8	56.25	
	Wood	11	61.818	
Hygiene/market	Dirty	54	51.296	0.0441
	Clean	8	35.625	
Hygiene/shop	Dirty	34	62.941	<0.0001
	Clean	28	32.678	
Hygiene/human	None	25	59	0.0017
	Apron	37	42.702	
	Mask	0		
	Glove	0		

Table 14: Variables in final model of Multivariate analysis of risk factors associated with proportion of *Salmonella* contamination in shops

Factors	P-value
Shop/knife	0.0632*
Hygiene/shop	<0.0001

*significant at p = 0.1000

4.3.2 Sample level

Number of *Salmonella* positive samples in each level of risk factor is shown in Table 15. There were seven out of 13 factors that were significantly (p= 0.1000) associated with sample prevalence in univariate analysis.

Table 15: Summary results of the assessment of associations between sample prevalence of *Salmonella* with potential risk factors (univariate analysis)

Factors	Level	No. of sample examined	n (+)	n (-)	% (+)	*P-value**
Chicken/source	Household	234	113	121	48.29	0.2927
	Farm	28	17	11	60.71	
Chicken/ slaughter by	Others	73	37	36	50.68	0.9388
	Retailer	189	93	96	49.2	
Chicken/ eviscerated	at home	197	99	98	50.25	0.8297
	at retail	65	31	34	47.69	
Water/source	Well	90	54	36	60	0.0214
	Tap	172	76	96	44.186	
Water/ chlorinated	No	90	53	37	58.88	0.0413
	Yes	172	77	95	44.76	
Water/storage	Close	8	5	3	62.5	0.7032
	Open	254	125	129	49.21	
Shop/knife	>1	85	35	50	41.18	0.0781
	= 1	177	95	82	53.67	
Shop/ chopper	>1	72	27	45	37.5	0.0228
	= 1	190	103	87	54.21	
Shop/worker	>1	111	50	61	45.04	0.2525
	= 1	151	80	71	52.98	
Shop/surface	Ceramic	15	4	11	26.66	0.0908
	Stainless steel	164	76	88	46.34	
	Steel	36	20	16	55.55	
	Wood	47	30	17	63.82	
Hygiene/market	Dirty	228	118	110	51.75	0.1081
	Clean	34	12	22	35.29	
Hygiene/shop	Dirty	142	91	51	64.08	<0.0001
	Clean	120	39	81	32.5	
Hygiene/human	None	117	69	48	58.97	0.0094
	Apron	145	61	84	42.06	
	Mask					
	Glove					

*P-value from Chi-square test

Of the seven factors, only four were found significantly ($p<0.05$) associated with the sample prevalence (Table 16). Four factors associated with sample prevalence of *Salmonella* were "number of knives used", "number of choppers used", "type of table surface" and "the hygiene status of shop".

Notably, the odds ratios of the number of choppers per shop, type of table surface (steel, stainless steel and wood) in the shop were greater than one. Thus they were strongly associated with the presence of *Salmonella* in the samples.

Table 16: Logistic regression of the risk factors associated with sample prevalence of *Salmonella*

Factors	Level	OR	P-value	95% CI
Shop/knife	>1	1	-	0
	=1	0.456347819	<0.001	[-1.0668, 0.3262]
Shop/chopper	>1	1		0
	= 1	2.150069141	<0.001	[0.4082, 1.1228]
Shop/surface	Ceramic	1	-	0
	Stainless steel	1.771629	0.0002	[0.2693, 0.8745]
	Steel	2.01980	0.0016	[0.2652, 1.1407]
	Wood	2.552568	0.0002	[0.4525, 1.4218]
Hygiene/shop	Dirty	1	-	0
	Clean	0.313893978	<0.001	[-1.5045, -0.8130]

Note:

OR = Odds ratio

OR = 1: no association exits between presence of *Salmonella* and factor

OR > 1: the factor is positively associated with the presence of *Salmonella* (risk factor)

OR < 1: the factor is negatively associated with the present of *Salmonella* (protective factor)