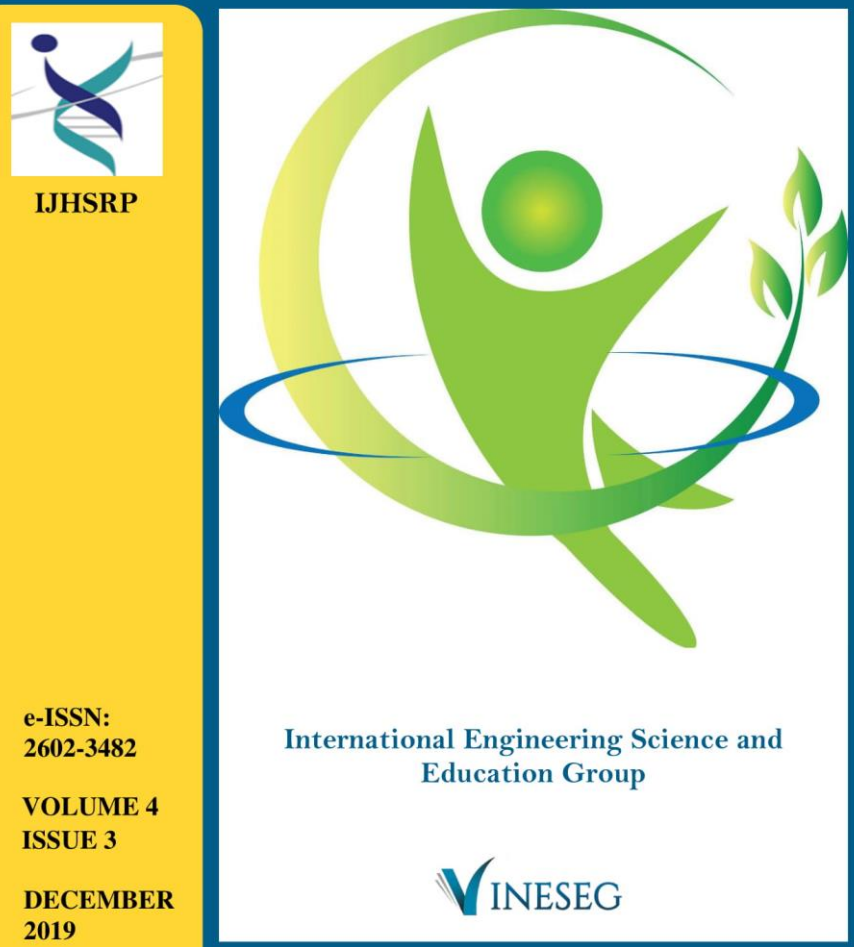
International Journal of Health Services Research and Policy



IJHSRP

e-ISSN: 2602-3482

VOLUME 4
ISSUE 3

DECEMBER 2019

International Engineering Science and Education Group

VINESEG

Email (for orders and customer services enquiries): info@ineseg.org

Visit our home page on www.dergipark.org.tr/ijhsrp

EDITORIAL BOARD MEMBERS

INESEG
INTERNATIONAL ENGINEERING, SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 .

IJHSRP

CONTENTS

Research Articles

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.01

IJHSRP

Research Article

A COST-EFFECTIVENESS COMPARISON OF THE OPEN AND LAPAROSCOPIC APPENDECTOMIES FOR PEDIATRIC PATIENTS

*Amita Bhadauria[1], Amogh Bhatnagar[2]

[1]Bradley University, Campus Town, Peoria, IL-61625, USA
[2]University School of Milwaukee, Milwaukee, WI 53217, USA
*Corresponding author: abhadauria@bradley.edu

Abstract: *Laparoscopic appendectomy (LA) is preferred to open appendectomy (OA), as it is less invasive. However, it is debatable whether LA is more cost-effective. We compared the cost-benefits of LA with OA, using the entire pediatric inpatient hospital data in the USA. The Kids' Inpatient Database (KID) shows that 51,007 pediatric patients were subjected to laparoscopic appendectomy and 12,668 to open appendectomy during 2010-12 across the USA. This dataset was used to assess the cost-effectiveness of LA and OA while controlling for the demographic characteristics of patients (e.g. age and gender), their background (e.g., place of residence), and complexity of surgery (e.g., number of procedures). We found that patients with laparoscopic surgery saved ~0.46 days of hospital stay, but paid $3641 more compared to patients with open surgery. Surgeons prefer to use the technologically advanced laparoscopic appendectomy (80% of patients). Our analysis shows that the cost-benefit of laparoscopic appendectomy is marginal. Hence, for making a fully informed decision, patients should be provided with both clinical and cost comparison data.*

Keywords: *open appendectomy, laparoscopic appendectomy, pediatric patient, economic cost, cross-sectional analysis.*

Received: September 9, 2019 Accepted: November 23, 2019

1. Introduction

Since the introduction of laparoscopic appendectomy (LA) in 1983[1], numerous studies have been done to compare the clinical effectiveness of laparoscopic and open appendectomies (OA). LA involves a minimally invasive surgical procedure compared to OA, resulting in less pain, shorter hospital stay, fewer complications and better cosmetic outcomes [2-7]. While studies report that the average length of hospital stay after LA is marginally decreased compared to OA [8], LA increases the chance of incidence of the intra-abdominal abscess (IAA) in complicated appendicitis [9-12]. However, with advancements in technology and the technical proficiency of surgeons, LA is now extensively used in complicated appendicitis [13-15], where it confers significant benefits in terms of wound healing.

The surgical procedures for LA require skilled surgeons, extra operating time and advanced surgical technologies, thus increasing the overall cost. There is a long tradition of studies comparing LA with OA [16 - 33], and Table 1 summarizes some of the major studies from across the world. The last two columns compare the outcomes of the two procedures, the first one in terms of hospital stay and the second one in terms of hospital charges. We reviewed studies from countries as diverse as the US, Finland, China, Columbia, etc. We also studied research that was carried out in the last twenty years. The overwhelming consensus from around the world and for the last twenty years

seems to be that LA is more expensive than OA, though it often leads to shorter hospital stay suggesting a quicker return to work and mobility.

Table 1: Literature Review

Study	The country where the study was carried out	Sample size	Did it study pediatric population?	Length of hospital stay was shorter after	Hospital charges were higher for
Martin et al. (1995)	USA	169	No	LA	OA
McCahill et al. (1996)	USA	162	No	No difference	LA
Richards et al. (1996)	USA	720	No	LA	No difference
Heikkinnen et al. (1998)	Finland	40	No	No difference	LA
Merhoff et al. (2000)	USA	-	No	No difference	LA
Long et al. (2001)	USA	198	No	LA	LA
Kurtz et al. (2001)	USA	758	No	LA	LA
Lintula et al. (2002)	USA	102	Yes	LA	Not studied
Ikeda et al. (2004)	Japan	100	Yes	LA	LA
Nguyen et al. (2004)	USA	60236	No	LA	No difference
Ignacio et al. (2004)	USA	52	No	LA	LA
Moore et al. (2005)	USA	Meta-analysis	No	Not studied	LA
Cothren et al. (2005)	USA	247	No	No difference	LA
Kehargias et al. (2008)	USA	293	No	LA	LA
Wei et al. (2010)	China	220	No	LA	No difference
Costa-Navarro et al. (2013)	Spain	142	No	LA	LA
Minutolo et al. (2014)	Italy	230	No	LA	No difference
Biondi et al. (2016)	Italy	593	No	LA	LA
Ruiz-Patino (2018)	Colombia	377	No	No difference	LA

This raises an intriguing question: does the additional cost of LA over OA justify the medical benefit? To address this question, we did a comparative and comprehensive analysis of the cost-effectiveness of LA and OA. While this type of investigation has been carried out by many other researchers, our study differs from the extant research in three crucial ways.

Patient recruitment is the most difficult and expensive aspect of any clinical study[34], including appendectomy[35], and therefore most clinical studies of appendectomy were conducted with small sample sizes (Please see the sample sizes of past studies in Table 1). This leads to selectivity bias because all demographic groups of patients and surgical complications were not adequately presented. Often, the larger retrospective studies are carried out with patients from one or two related hospitals, leading to controversial and contradictory outcomes. Of the twenty studies that we reviewed, only one had a large enough population [24]. To avoid the biases associated with small sample sizes, we analyzed the entire US pediatric population to assess the cost-effectiveness of LA and OA (over 3 million records).

Most studies involve adult subjects (please see Table 1). Of the twenty studies that we found, only one [13] focused on the pediatric population. Since children bodies are much smaller than adults, room for maneuvering the laparoscopic surgical equipment is much more limited, leading to a

higher probability of side-effects, such as Intra-abdominal abscess (IAA). This constrains the advantages of LA. We focus exclusively on the pediatric population.

The outcome of surgical procedures would depend on patient characteristics. For instance, as children get older, their bodies grow and create more room to maneuver the laparoscopic surgical equipment, increasing the advantages of LA. We, therefore, used several control variables in our study that we believe would affect the success of LA, such as demographic characteristics of patients (e.g., age, gender, place of residence), day of surgical procedure (e.g., weekday and weekend), number of procedures (e.g., stitch or staple after surgical incision) and type of appendectomy (e.g., LA or OA).

There are three ways this research improves upon past studies. First, it focuses on the pediatric population, rather than the adult population. Second, it studies the entire US pediatric population as opposed to small sample size. Third, it controls for several patient characteristics.

2. Methods

Database: We used the Kid's Inpatient Database (KID), a member of the large family of healthcare databases developed for the Healthcare Cost and Utilization Project (HCUP). The HCUP-KID releases a vast amount of information on hospital inpatient stays of children (age <20 years) every three years. Here we focused our study on the 3 million patient records released from 2010-2012. During this period, 12,668 pediatric patients had an open appendectomy and 51,007 had a laparoscopic appendectomy. The ICD-9 procedure codes for open and laparoscopic appendectomy are 47.09 and 47.01, respectively.

From this dataset, the average length of stay in a hospital for each procedure was extracted. Typically, the duration of hospital stay is treated as a summary measure of recovery time with an assumption that patients are released from a hospital when they have attained the same level of recovery or pre-operative functional status[36]. Greater the operative or postoperative complications, the greater is expected to be the recovery time. We also extracted information on the total hospital charges from the billing discharge data.

Analysis of data: A number of factors, including patient demography, time of procedure and surgical complexities, are known to influence the treatment outcomes of appendectomy. For instances, Cheong and Emil (2014) show that the domicile status of patients is a determinant of the treatment outcome of appendectomy[37]. Al-Qurayshi et al. (2016) found that the complication after appendectomy depends on the day of the procedure (weekday or weekends)[38]. Tuggle et al. (2010) report that LA is superior to OA in term of wound infection[39]. Lee et al. (2011) concluded that among pediatric patients, older ones are more likely to have LA and males are more likely to have OA[8].

To determine the relationship between the length of hospital stay, hospital charges, and types of appendectomy, we had taken the above-mentioned factors (age, gender, place of residence, time of procedure and complexity of procedures) as controls. The relationship between dependent variables (i.e., length of hospital stay and hospital charge) and the independent variable (whether patient had LA or OA) and five control variables (age, gender, location of residence, number of procedures, and day of procedure) were tested by the following multiple linear regression equation[40].

$$Y_{im} = \alpha_m + \sum_n \beta_{mn} X_{imn}$$

where Y_{im} is the mth dependent variable for individual i. m can take only two values as there are only two dependent variables: length of hospital stay and hospital charges. n indexes the independent variables and X_{imn} is the nth independent variable for individual i. Here, α_m is the intercept for the mth dependent variable and β_{mn} are the corresponding regression coefficients.

3. Results and Discussion

31. Data descriptive statistics

Data of 63,695 patients who had uncomplicated or complicated appendectomies are described in Table 1. This analysis shows that the average length of stay in hospital was 3 days (standard deviation = 6.24 days), the average hospital charge was $35,498.00 (standard deviation = $65, 441), and more than four-fifth of patients (80.1%) were operated by laparoscopic procedures. The average number of procedures carried out on patients was 1.4. Nearly one-fourth of patients (25.7%) were admitted on weekends.

Table 2. Descriptive Statistics

Variable	Mean	St Deviation
Length of hospital stay	2.98 days	6.24 days
Total hospital charges	$ 35,497.73	$ 65,440.82
Age	12.62 years	4.86 years
Number of procedures	1.4	1.20
	Frequency	Percentage
Gender		
Male	37566	59.0
Female	26104	41.0
Admission day is a weekend		
No	47299	74.3
Yes	16376	25.7
Type of appendectomy		
Open	12668	19.9
Laparoscopic	51007	80.1
Place of Residence		
Central counties >= 1 million	21786	34.2
Fringe counties >= 1 million	14592	22.9
Counties pop: 250,000 -999,999	12894	20.2
Counties pop: 50,000 - 249,999	5303	8.3
Micropolitan counties	5436	8.5
Non-core counties	3473	5.5
Race		
White	30439	47.8
Black	3966	6.2
Hispanic	20414	32.1
Asian/Pacific Islander	1573	2.5
Native American	654	1.0
Other	3181	5.0

The KID data accurately represent a large patient population, ranging from newborn to 20 years old children, with an average age being 12.6 years. Nearly 60% of patients were male. More than one-third of patients were from large metropolitan areas. Patients were classified based on their residential location (Table 2). As expected, the proportion of patients located in a county goes down as the location of residence becomes more rural (e.g., 34.2% in the central county whereas 5.5% in the non-core counties). Nearly half the patients (47.8 %) were white and one-third were Hispanic (32.1%), with reasonable representation from other racial groups (see Table 2, bottom rows).

3.2. The relative length of hospital stay after open and laparoscopic appendectomies

The multiple linear regression model was used to determine the relationship between the length of the hospital stay and multiple variables such as type of appendectomy, age, gender, place of residence, day of procedure, and number of procedures (see Table 3).

Table 3. Length of Hospital Stay

	Regression Coefficient	Standard Error	t - stats	p value
Intercept	.519	.080	6.48	.00
Age in years at time of admission	-.144	.004	-36.69	.00
Whether admission day is a weekend (1=Yes, 0=No)	.021	.043	.48	.63
Gender (1=Female, 0=Male)	-.091	.038	-2.40	.02
Place of Residence	.039	.013	3.07	.00
Number of procedures	3.284	.016	204.73	.00
Laparoscopic (1=Yes, 0=No)	-.460	.048	-9.52	.00

Total number of observations: 63675
F stats: 8013.025 (sig: 0.000)
R square: 0.431

Here, we found that the intercept value was 0.519. Theoretically, it indicates that the length of hospital stay is 0.519 days for a male child (< 1-year-old), who had an open appendectomy without any medical procedure on a weekday in a county with a population greater than 1 million (metro area). As every patient must have at least one procedure, the actual hospital stay for the male child would be minimum 3.8 days (0.519 + the regression coefficient for Number of procedures = 3.284 with p-value <0.05). It also implies that the number of medical procedures has the greatest impact on the length of stay. For every increase in one procedure, the length of stay increases by 3.284 days. In other words, if everything else remains constant, a 10-year old child will stay in the hospital for 1.4 days less than a newborn, and a 20-year old person will stay for 2.8 days less than a newborn. Our analysis also suggested that the length of stay was more for patients in rural hospitals (regression coefficient = 0.039 with p-value <0.05), but had no effect on weekdays or weekend admission of

patients (p-value > 0.63) as reported earlier [41]. Furthermore, our analysis suggests that for every increase of one year in a patient's age, the length of the hospital stay decreases by 0.144 days (regression coefficient = - 0.144 with p-value <0.05). The length of hospital stay was found to be significantly different when the procedure was laparoscopic. If everything else remains constant, patients with laparoscopic surgery spend 0.46 days less (regression coefficient = -0.46 with p-value <0.05).

3.3. The relative cost of open and laparoscopic appendectomies

Results from the regression model run on total hospital charges are presented in Table 4.

Table 4. Total Hospital Charges

	Regression Coefficient	Standard Error	t - stats	p-value
Intercept	-1750.589	910.643	-1.922	.06
Age in years at the time of admission	-537.492	44.586	-12.06	.00
Whether admission day is a weekend (1=Yes, 0=No)	1.351	486.508	.00	.99
Gender (1=Female, 0=Male)	-276.496	432.513	-.64	.52
Place of Residence	-1635.539	142.019	-11.52	.00
Number of procedures	32456.482	183.637	176.74	.00
Laparoscopic (1=Yes, 0=No)	3640.607	547.386	6.65	.00

Total number of observations: 63675
F stats: 5550.847 (sig: 0.000)
R square: 0.350

The intercept value was found to be zero (p > 0.05), suggesting that the hospital charges for a patient less than one year in age, undergoing open appendectomy with one procedure, and residing in a county with population greater than 1 million, would be $ 32,456 (see Table 4, number of procedures, regression coefficient = 32456.482). For every year increase in age, the hospital charges decrease by $537 (regression coefficient = -537.492 with p < 0.05). The gender of the patient and whether admitted on a weekday or weekend has no effect on the hospital charges (p > 0.05). Interestingly, the hospital charges were low among patients in rural hospital (regression coefficient = -1635.539 with p < 0.05). The number of procedures again has the largest impact on hospital charges (regression coefficient = -32456.482 with p < 0.05), suggesting that the cost of surgery increases with the increase of procedures. We found that the second biggest impact on hospital charges is from the type of procedure. If everything else remains constant, patients with laparoscopic surgery pay $3,640 more than patients with open appendectomy (regression coefficient = 3640.607 with p < 0.05).

3.4. The side effects of open and laparoscopic appendectomies

The frequency of occurrence of various side-effects associated with appendectomy are summarized in Table 5.

Table 5. Incidences of Side Effects

Side-effect	OA	LA	Total Incidences
Death	18 (0.1%)	0 (0.0 %)	18 (0.03 %)
Intra-abdominal abscess (IAA)	55 (0.4 %)	142 (0.3 %)	197 (0.3 %)
Paralytic ileus (PI)	854 (6.7 %)	2124 (4.2 %)	2978 (4.7 %)
Surgical site infection (SSI)	170 (1.3 %)	240 (0.5 %)	410 (0.64 %)

Total number of observations: 63675
The numbers in brackets are the percentages

During this period 18 deaths occurred exclusively among OA patients. However, death occurred only in 0.03% of the appendectomies. The most common side-effect was Paralytic Ileus (PI) that occurred in 4.67% of the appendicitis patients. PI occurs more commonly after OA (6.7%) compared to LA (4.2%). 1.3% of OA lead to surgical site infection as opposed to 0.5% for LA. Unlike the Paralytic Ileus and the surgical site infection, occurrences of IAA after OA and LA are 0.4% and 0.3%, respectively; suggesting that the occurrence of IAA is rare among appendicitis patients. Overall, it appears that OA is worse than LA in terms of side-effects, but the overall incidences of the different side effects are too small.

4. Conclusion

Multiple factors influence the clinical outcomes of appendectomies. These factors include patient's demographic features (e.g., age, gender and health status), their background (e.g., place of residence), day of surgical procedure (e.g., weekday and weekend), number of procedures (e.g., stitch or staple after surgical incision), and type of appendectomy (e.g., LA or OA). Using a large set of nationwide inpatient data, we systematically investigated how these multiple variables influenced the length of hospital stay and the associated health-care cost after appendectomies. Our studies showed that patients with laparoscopic appendectomy saved only 0.46 days of hospital stay (Table 3) and spent ~$3,640 more than patients with open appendectomy (Table 4). This extra-cost appears to be due to fees of skilled surgeons and expenses needed to operate and maintain the advanced surgical tools. Thus, it is a debate to choose the proper technique for an appendectomy.

Surgeons normally prefer laparoscopic surgery because it is associated with less pain, shorter hospital stays, fewer complications and better cosmetic outcomes (80% of the appendectomies were laparoscopic, Table 2)(4,10,42). Our analysis further showed that the number of laparoscopic appendectomies, between 2010 and 12, was 85% in metro (urban) counties and 67% in non-

metropolitan (rural) counties. This suggests that laparoscopic appendectomy has also been gradually replacing open appendectomy for the treatment of appendicitis in all counties, depending upon the availability of skilled surgeons, advanced tools and complexity of appendicitis. However, our analysis showed that the laparoscopic patients spent an extra ~$3,640. An obvious question is whether a shorter hospital stay (0.46 days) is really worth the extra cost. It is likely that some patients, particularly with low economic status, would prefer to stay in the hospital for an extra half-day to save $3640.

Due to the lack of data, we did not consider the 'unmeasured' benefits of the laparoscopic approach including post-operative pain and its psychological implications on the child population. The study also does not take into account the long term complications e.g. wound complications and their cost. However, this should not detract from the main contribution of this study – all surgical procedures should be compared to their costs as well as medical benefits.

Like appendectomy, laparoscopic surgery is routinely practiced to treat a large number of medical conditions, such as cholecystectomy[42] and hysterectomy[43]. Thus, the methodology demonstrated in this study can be used to compare any set of surgical approaches on both clinical outcomes and costs. At a time of rising health care costs, any strategy for the reduction of in-patient care expenditure should be of interest to patients, health care insurers, and policymakers.

References

[1] Semm, K., "Endoscopic appendectomy", *Endoscopy* 15, 59-64, 1983.

[2] Slim, K., Pezet, D., and Chipponi, J., "Laparoscopic or open appendectomy? A critical review of randomized, controlled trials", *Dis Colon Rectum* 41, 398-403, 1998.

[3] Garbutt, J. M., Soper, N. J., Shannon, W. D., Botero, A., and Littenberg, B., "Meta-analysis of randomized controlled trials comparing laparoscopic and open appendectomy", *Surg Laparosc Endosc* **9**, 17-26, 1999.

[4] Chung, R. S., Rowland, D. Y., Li, P., and Diaz, J., "A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy", *Am J Surg* **177**, 250-256, 1999.

[5] Temple, L. K., Litwin, D. E., and McLeod, R. S. "A meta-analysis of laparoscopic versus open appendectomy in patients suspected of having acute appendicitis", *Can J Surg* 42, 377-383, 1999.

[6] Schirmer, B. D., Schmieg, R. E., Dix, J., Edge, S. B., and Hanks, J. B., "Laparoscopic [V]ersus Traditional Appendectomy for Suspected Appendicitis", *American Journal of Surgery* 165, 670-675, 1993.

[7] Yau, K. K., Siu, W. T., Tang, C. N., Yang, G. P., and Li, M. K., "Laparoscopic versus open appendectomy for complicated appendicitis", *J Am Coll Surg.*, 205, 60-65, 2007.

[8] Lee, S. L., Yaghoubian, A., and Kaji, A., "Laparoscopic vs Open Appendectomy in Children Outcomes Comparison Based on Age, Sex, and Perforation Status", *Arch Surg-Chicago.*, 146, 1118-1121, 2011.

[9] Tang, E., Ortega, A. E., Anthone, G. J., and Beart, R. W., "Intraabdominal abscesses following laparoscopic and open appendectomies", *Surg Endosc-Ultras* **10**, 327-328, 1996.

[10] Golub, R., Siddiqui, F., and Pohl, D., "Laparoscopic versus open appendectomy: A meta-analysis", *J Am Coll Surgeons*, 186, 545-553, 1998.

[11] Sauerland, S., Lefering, R., and Neugebauer, E. A., "Laparoscopic versus open surgery for suspected appendicitis", *Cochrane Database Syst Rev*, CD001546 (2004)

[12] Pokala, N., Sadhasivam, S., Kiran, R. P., and Parithivel, V., "Complicated appendicitis - Is the laparoscopic approach appropriate? A comparative study with the open approach: outcome in a community hospital setting", *Am Surgeon*, 73, 737-741, 2007.

[13] Lintula, H., Kokki, H., Vanamo, K., Antila, P., and Eskelinen, M., "Laparoscopy in children with complicated appendicitis", *Journal of Pediatric Surgery*, 37, 1317-1320, 2002.

[14] Wullstein, C., Barkhausen, S., and Gross, E., "Results of laparoscopic vs. conventional appendectomy in complicated appendicitis", *Diseases of the Colon & Rectum*, 44, 1700-1705, 2001.

[15] Ng, W. T., Lee, Y. K., Hui, S. K., Sze, Y. S., Chan, J., Zeng, A. G. Y., Wong, C. H., and Wong, W. H., "An optimal, cost-effective laparoscopic appendectomy technique for our surgical residents", *Surg Laparo Endo Per*, 14, 125-129, 2004.

[16] Martin, L.C., Puente, I., Sosa, J.L., Bassin, A., Breslaw, R., McKenney, M.G., Ginzburg, E. and Sleeman, D., "Open versus laparoscopic appendectomy. A prospective randomized comparison", *Annals of Surg*, 222, 256-262, 1995.

[17] McCahill, L.E., Pellegrini, C.A., Wiggins, T. and Helton, W.S., "A clinical outcome and cost analysis of laparoscopic versus open appendectomy", *The American J of Surg*, 171, 533-537.1996.

[18] Richards, K.F., Fisher, K.S., Flores, J.H. and Christensen, B.J., "Laparoscopic appendectomy: comparison with open appendectomy in 720 patients", *Surgical Laparoscopy & Endoscopy*, 6, 205-209, 1998.

[19] Heikkinen, T.J., Haukipuro, K. and Hulkko, A., "Cost-effective appendectomy", *Surgical Endoscopy*, 12, 1204-1208, 1998.

[20] Merhoff, A.M., Merhoff, G.C. and Franklin Jr, M.E., "Laparoscopic versus open appendectomy", *The American J of Surg*, 179, 375-378, 2000.

[21] Long, K.H., Bannon, M.P., Zietlow, S.P., Helgeson, E.R., Harmsen, W.S., Smith, C.D., Ilstrup, D.M., Baerga-Varela, Y., Sarr, M.G. and Group, L.A.I., "A prospective randomized comparison of laparoscopic appendectomy with open appendectomy: clinical and economic analyses", *Surgery*, 129, 390-400, 2001.

[22] Kurtz, R.J. and Heimann, T.M., "Comparison of open and laparoscopic treatment of acute appendicitis", *The American J of Surg*, 182, 211-214, 2001.

[23] Ikeda, H., Ishimaru, Y., Takayasu, H., Okamura, K., Kisaki, Y. and Fujino, J., "Laparoscopic versus open appendectomy in children with uncomplicated and complicated appendicitis", *Journal of Pediatric Surg*, 39, 1680-1685, 2004.

[24] Nguyen, N.T., Zainabadi, K., Mavandadi, S., Paya, M., Stevens, C.M., Root, J. and Wilson, S.E., 'Trends in utilization and outcomes of laparoscopic versus open appendectomy", *The American J of Surg*, 188, 813-820, 2004.

[25] Ignacio, R.C., Burke, R., Spencer, D., Bissell, C., Dorsainvil, C. and Lucha, P.A., "Laparoscopic versus open appendectomy: what is the real difference? Results of a prospective randomized double-blinded trial", *Surgical Endoscopy And Other Interventional Techniques*, 18, 334-337, 2004.

[26] Moore, D.E., Speroff, T., Grogan, E., Poulose, B. and Holzman, M.D., "Cost perspectives of laparoscopic and open appendectomy". *Surgical Endoscopy and Other Interventional Techniques*, 19, 374-378, 2005.

[27] Cothren, C.C., Moore, E.E., Johnson, J.L., Moore, J.B., Ciesla, D.J. and Burch, J.M., "Can we afford to do laparoscopic appendectomy in an academic hospital?", *The American J of Surg*, 190, 973-977, 2005.

[28] Kehagias, I., Karamanakos, S.N., Panagiotopoulos, S., Panagopoulos, K. and Kalfarentzos, F., "Laparoscopic versus open appendectomy: which way to go?", *World J of Gastroenterology*, 14, 4909, 2008.

[29] Wei, H.B., Huang, J.L., Zheng, Z.H., Wei, B., Zheng, F., Qiu, W.S., Guo, W.P., Chen, T.F. and Wang, T.B., "Laparoscopic versus open appendectomy: a prospective randomized comparison", *Surgical Endoscopy*, 24, 266-269, 2010.

[30] Costa-Navarro, D., Jiménez-Fuertes, M. and Illán-Riquelme, A., "Laparoscopic appendectomy: quality care and cost-effectiveness for today's economy", *World J of Emergency Surg*, 8, 45, 2013.

[31] Minutolo, V., Licciardello, A., Di Stefano, B., Arena, M., Arena, G. and Antonacci, V., "Outcomes and cost analysis of laparoscopic versus open appendectomy for treatment of acute appendicitis: 4-years experience in a district hospital." *BMC Surgery*, 14, 14, 2014.

[32] Biondi, A., Di Stefano, C., Ferrara, F., Bellia, A., Vacante, M., and Piazza, L., "Laparoscopic versus open appendectomy: a retrospective cohort study assessing outcomes and cost-effectiveness", *World J Emerg Surg*, 11, 44, 2016.

[33] Ruiz-Patino, A., Rey, S., Molina, G., Dominguez, L. C., and Rugeles, S., "Cost-effectiveness of laparoscopic versus open appendectomy in developing nations: a Colombian analysis", *Journal of Surgical Research*, 224, 33-37, 2018.

[34] Thoma, A., Farrokhyar, F., McKnight, L., and Bhandari, M., "How to optimize patient recruitment", *Canadian Journal of Surgery*, 53, 205-210, 2010.

[35] Cadeddu, M., Farrokhyar, F., Thoma, A., Haines, T., Garnett, A., Goldsmith, C. H., and Grp, E.-B. S. W., "Users' guide to the surgical literature: how to assess power and sample size", *Canadian Journal of Surgery*, 51, 476-482, 2008

[36] Rotter T, K. L., James E, Machotta A, Gothe H, Willis J, Snow P, Kugler J., "Clinical pathways: effects on professional practice, patient outcomes, length of stay and hospital costs", *Cochrane Database Syst Rev*, 303, 2010.

[37] Cheong, L. H. A., and Emil, S., "Determinants of appendicitis outcomes in Canadian children", *Journal of Pediatric Surgery*, 49, 777-781, 2014.

[38] Al-Qurayshi, Z., Kadi, A., Srivastav, S., and Kandil, E., " Risk and outcomes of 24-h delayed and weekend appendectomies", *Journal of Surgical Research*, 203, 246, 2016.

[39] Tuggle, K. R., Ortega, G., Bolorunduro, O. B., Oyetunji, T. A., Alexander, R., Turner, P. L., Chang, D. C., Cornwell, E. E., 3rd, and Fullum, T. M., "Laparoscopic versus open appendectomy in complicated appendicitis: a review of the NSQIP database", *J Surg Res* 163, 225-228, 2010.

[40] Maddala, G. S., & Lahiri, K., Introduction to econometrics (Vol. 2), *New York: Macmillan*, 1992.

[41] Worni, M., Ostbye, T., Gandhi, M., Rajgor, D., Shah, J., Shah, A., Pietrobon, R., Jacobs, D. O., and Guller, U., "Laparoscopic appendectomy outcomes on the weekend and during the week are no different: a national study of 151,774 patients", *World J Surg* 36, 1527-1533, 2012.

[42] Kiviluoto, T., Siren, J., Luukkonen, P., and Kivilaakso, E., "Randomised trial of laparoscopic versus open cholecystectomy for acute and gangrenous cholecystitis", *Lancet*, 351, 321-325, 1998.

[43] Siesto, G., Giudici, S., Seveso, A., Zefiro, F., Mellana, L., Ceravolo, G., Volpi, E., and Donadello, N., "Surgicopathologic outcome of laparoscopic versus open radical hysterectomy", *Int J Gynecol Cancer*, 17, 944-945, 2007.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.02

IJHSRP

Research Article

DETERMINATION OF OCCUPATIONAL COMPUTER USAGE LEVELS OF NURSES IN MEDICAL INSTITUTIONS: A REAL HOSPITAL CASE STUDY

Alaattin Parlakkılıç [1]

[1]Department of Management Information Systems, Ufuk University, Turkey

* Corresponding author; aparlakklc@gmail.com

Abstract: *With the development of technology, the role and responsibility of nurses in various health institutions have changed. The main purpose of this change is to provide better quality health services to individuals. This research aims to investigate the Information Technology Readiness of Public Health Nurses in Turkey. A survey was done with a total of 104 nurses. To measure IT readiness, technological skills readiness, attitude readiness, task-ready information technology readiness and institutional support readiness were evaluated using a five-point Likert scale. The scores of the participants were evaluated as technological skills readiness was 3.83 (76,6 %); attitude readiness was 3.67 (73,4 %), task-ready information technology readiness was 3.85 (77%) and institutional support readiness was 3.65 (73 %). The results of the dimensions show that nurses are extremely prone to use technology in their work. The overall results show that the information technology readiness for nurses has been found at 3.75 (75 %) and needs a few improvements.*

Keywords: *Information technology readiness, technological skills, attitude, task-ready, institutional support*

Received: July 20, 2019 Accepted: November 26, 2019

1. Introduction

Information Technology (IT) has affected the delivery of healthcare services and gives ways to use health applications among health services providers and patients. Health Information Technology platforms are specifically targeted at assisting individuals and wellness management. Information Technology reaches more than 90% of the world's population [1].

Nurses can improve patient health and minimize the need for office visits for the routine management of some of the acute and chronic issues by using IT tools. Nurses can track patients proactively by text message, e-mail, telephone call, and, if significant enough, an office visit [2].

Information technology is expected that nurses take an active role within health institutions and bring solutions to the problems that arise [3]. In the health system, quality and timely information are of great importance. In this case, computer systems and technology are of vital importance in the developing health system [1].

The current situation of IT in medical support can promise nurses to manage and support healthcare problems to solve. With the development and availability of smart and mobile devices, uninterrupted access to information technologies is possible. Information technologies and new communication facilities are used in healthcare services as well as in the research and training of staff in this field [4].

This study aims to reveal the information technology readiness levels of nurses and to investigate the effects on nurses. For this aim, the following sub-objectives will be sought to determine the nurses' information technology readiness levels and its effects:

1. What are the levels of technological skills readiness, attitude readiness, task-ready readiness and institutional readiness of nurses?
2. What is the relationship between the dimensions of information technology readiness of nurses?
3. What is predictive for IT readiness for nurses?
4. What is the overall level of information technology readiness of nurses?

2. Information Technology in Healthcare

Health Information technology has a variety of objectives such as improving medication adherence or helping patients gain control of chronic conditions regardless of the problems trying to solve or condition. Health Information technologies may have any of the following functions or they may combine them to achieve the desired result. Functions of Health Information Technologies can be stated as follows [5]:

- Inform
- Advise
- Communicate
- Measure
- Monitor
- Motivate.

In nursing, information technologies and nurses' knowledge about patient care are synthesized more easily. First of all, the knowledge and skills of basic information technologies are needed. As a result, there will be a significant increase in the knowledge and proficiency levels of nurses if they have competency in IT. Information technologies are used in nursing for the following purposes [3]:

- Record nursing practices,
- Registration of products used in nursing services,
- Researches,
- Care and treatment of individuals,
- Providing educational activities to health workers,

Nursing practices in light of current information and computer usage are important. Nurses should have sufficient information and skills at a desirable quality. Nursing activities about patients during their task-based jobs can be mentioned as follows [24]:

- Patients Training of patients,
- Creating a program for patient care,
- Planning the delivery time of drugs,
- Record the requests of physicians,
- Obtaining medicines from a pharmacy.

Through integrating, patient-reported outcomes or results of passive data collection Health Information technologies may provide data visualization allowing both patients and nurses can monitor a patient’s condition, track progress over time and seek to motivate patients to make better health

decisions. This can be done with messages that reach patients at the right time, such as when they need to take their medication [6].

Most Health Information technologies consist of three generic functions which are delivery, promotion and monitoring and evaluation. Delivery provides to conduct diagnosis and provide care with maintaining timeliness and tracking. Promotion creates awareness among patients and helps to adopt healthy behaviors. In health promotion, appropriate healthy practices and assistances help towards the aimed behavioral goals [7].

Monitoring and evaluation improve the delivery and promotion actions in health. In the monitoring data, collection and analyses are the main efforts for the information system. Nurse experts agree it's important for nurses to get involved in the development of Health Information tools that support patients as well as themselves in their clinical practice. So, to empower lifestyle management through the use of Health Information tools, nurses must understand both the potential and limitations of technologies for helping patients to manage a healthy lifestyle [8].

Smartphones and wearable activity trackers and Web-based applications can be used to improve patient care and empower families in the process. Health Information technology has areas of focus include:

- Improving patient compliance
- Disseminating health information among the community
- Remote diagnosis and support for on-the-ground health care workers
- Health data entry and disease surveillance
- Emergency Response [9].

When considering mobile Technologies, global coverage and device technology support require the selection of any device or service for ensured data security, integrity, quality, and privacy. The right Health technology for needs generally depends on evaluating the following criteria:

- Type and purpose of data to be collected
- Quality and frequency of data collection needed to meet study goals
- Reliability, maturity, and capability of the technology
- Regulations and guidance
- Participant compliance and scope of device capabilities
- Study populations
- Geographies where data collection will take place
- Budget, timelines, and support
- Technological skills readiness [10].

Health Information technologies have obstacles when implementation and utilization take place which include:

- Establishing hospital administrator support;
- Overcoming staff resistance to change;
- Training to different learning styles and comfort levels with technology;
- Securing patient confidentiality;
- Cost of infrastructure and maintaining consistent internet access;
- Failure or malfunction of handheld devices; and
- Ensuring that mobile devices are not a distraction in the workplace [9].

When we look at the Health Information technology studies which have been done until now, especially smartphone and its functionalities have been extensively used. In this context, a survey done in 2015 by InCrowd, showed that 95% of nurses own a smartphone and 88% of them use smartphone apps at work. A total of 73 percent of polled nurses use smartphones to access clinical data particularly information on drug interactions. Also, 72 percent of survey takers use mobile health apps to learn about medical conditions and disorders In February 2014, Wolters Kluwer's survey revealed that nurses' use of smartphones was 67% and medical residents by 80%. Also in *mHealth App Developer Economics* 2014 report, fitness, medical reference, and wellness apps made up the largest categories [11]. A recent U.S. Department of Education report provides subject vocabulary and discıss an explicit comprehension strategy of IT for health motivation [12].

3. Readiness

Readiness is a concept defined differently in the literature. This includes psychological and physiological concepts that the individual needs to show certain behavioral competencies. Institutional changes are included in organizational development activities. The effectiveness and success of these changes depend on many factors. Readiness to change is one of the most important of these factors [2].

Holt and Vardaman [13] reported that conceptual readiness for change is composed of both individual differences and structural elements. The readiness reflects the level of acceptance and adoption of a change plan for the change of a certain status quo by the organization and its members. These writers refer to the readiness to change declares "Let's think of an organization that is full of enthusiastic and energetic individuals for a new initiative, but not in terms of equipment. It is not possible to say that this organization is more prepared than an organization consisting of full but unwilling individuals. For this reason, we argue that the elements of individual and structural differences should be taken into consideration" [13].

The readiness to change is a factor that has a significant impact on the attitude of the employees towards change implementation and thus on the success measure of this initiative. A study on nurses reveals that nurses are positive in the use of computers in the field of health. According to this, the individual characteristics of the nurses are effective in the degree of computer use [14].

IT readiness provides information for the specific needs of learning. All aspects of learning including students, lecturers, technology and the environment must be ready before implementation [15].

This study explores four dimensions to measure IT readiness that has been identified by investigating previous researches. So, information technology readiness has been examined in four dimensions as technological skills readiness, attitude readiness, task-ready information technology readiness and institutional support readiness. These dimensions are defined as follows:

Technological Skills Readiness: The concept of technical skill readiness usually focuses on the learning of technological infrastructures. Technological readiness refers to the observable and measurable technical competencies [16].

Attitude Readiness: The concept of attitude readiness is closely related to concepts such as trust, risk control, concern, and satisfaction. The responses of individuals to change can vary. Sometimes individuals adopt changes quickly and sometimes take a long time to absorb these changes [17].

Task-ready Information Technology Readiness: Information technology readiness for the task is the ability of individuals to work with high efficiency from business life depends on their ability to

benefit from these technological tools. The requirements in working life increase: more knowledge is necessary as well as flexibility referring to a fast familiarization with new working environments [18].

Institutional Support Readiness: The corporate support readiness can be listed as superiors' support, peer support, and positive organizational atmosphere [19]. People can work more easily in business environments where receive support. Readiness refers to whether a learner/trainee or an institution is financially ready for an e-learning program [12]. Institutional Support considerations of implementing within organizations seem to take a central place within the existing literature.

4. Methods

4.1. Study design

This study employed a survey to examine the occupational computer usage level of the nurses working at Ufuk University Hospital in Ankara. The total number of nurses in the hospital is 160. The questionnaires were distributed to all nurses, but 104 nurses returned the survey. The research method is cross-sectional and descriptive. In the first part, there were questions to determine the demographic information of the participants. The second part was used to identify the information technology readiness of the participants.

The questionnaire consisted of 5 sizes of Likert type (1 = strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree 5 = strongly agree). The dimensions have been as technological skills readiness, attitude readiness, task-ready information technology readiness and institutional support readiness in the survey.

The findings of the demographic information of the participants were firstly analyzed by the frequency analysis method. Then, for each readiness dimension, the mean and the mean values of the items were calculated. It was seen that the variables were consistent with the normal distribution by looking at the skewness and kurtosis values. The skewness value (Skewness) is within ± 1 limits, and the kurtosis value (Kurtosis) is within ± 2 boundaries. Therefore, parametric tests used in the analysis. Pearson correlation analysis was used to determine the relationships between readiness dimensions. Then, the readiness dimensions were analyzed with independent sample t-test and one-way ANOVA.

As the question items for the questionnaire dimensions are at a 5-point Likert type, it is assumed that the participants who score 3.40 and above for the scoring are expected to be at the expected readiness level [17].

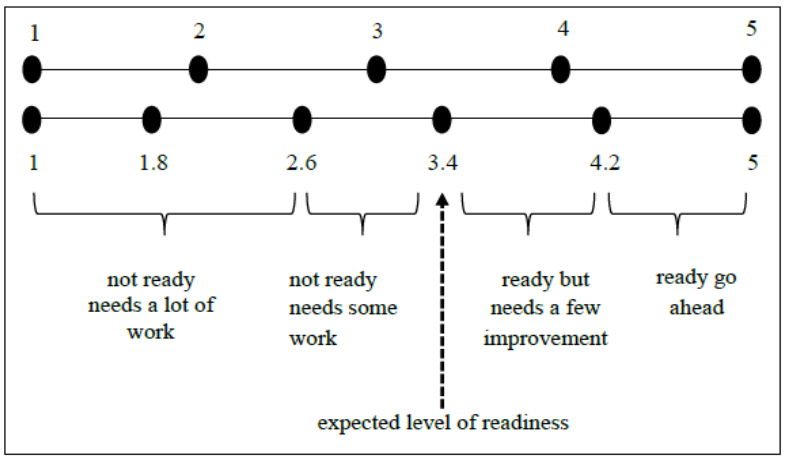


Figure 1. Evaluation Criteria for Readiness

5. Results

5.1. Demographic Information

The survey was administered to the 104 nurses. The details of demographics are as shown in Table1.

Table 1. Frequency Analysis Results of Demographic Information

	Frequency	Percent
Gender		
Female	80	76,9
Male	24	23,1
Age		
25 years and under	41	39,4
Between 26-30 years	22	21,2
Between the ages of 31-35	27	26,0
36 years and older	13	12,5
Education status		
Graduate or graduate degree	30	34,6
High School, Associate Degree or Certified	70	63,4
Marital status		
Married	39	37,5
Single	65	62,5
Information technology access		
Internet connection at home	72	70,6
Workplace	56	54,9
Mobile phone / tablet / PDA	87	85,3
Wi-Fi HotSpots	7	6,9
Internet cafe	2	2,0
School / university	4	3,9

Gender: As a result of the independent sample t-test, technological skills, attitude readiness, information technology readiness for the task and institutional support readiness did not differ according to the gender of the participants and are respectively shown in Table2.

Age: As a result of the one-way analysis of variance, it has been found that organizational support readiness does not differ significantly from the participants' age, F (3, 99), p>, 05. On the other hand, technological skills, attitude readiness, and information technology readiness for the task differed significantly from participants' readiness, according to the age of participants and are respectively shown in Table2.

Bonferroni Post-hoc analysis was performed to determine the significant differences among the groups. Accordingly, it was found that the technological skills and attitude readiness of the participants under the age of 25 were significantly higher than the participants over the age of 36 years. Also, it was found that participants in the age group 25 were significantly more likely to have information technology readiness for the task than the participants aged 26 to 30 years.

Education level: As a result of the independent sample t-test, it has been found that technological skills, attitude readiness, information technology readiness for the task and institutional support readiness do not differ significantly according to the education level of the participants and are respectively shown in Table2.

Marital status: As a result of the independent sample t-test, it was found that technological skills, attitude readiness, task-oriented information technology readiness and institutional support readiness did not differ significantly according to the marital status of the participants, respectively and are respectively shown in Table2.

Table2. Results of Demographic Information with respect to IT Readiness Dimensions

	Gender		Age		Education level:		Marital status:	
	t	P	F	p	*t*	*P*	*t*	*P*
Technological Skills readiness	-0, 961	>, 05	4,887	p <, 05	1,883	p>, 05	-0, 367	p>, 05
Attitude readiness	0,294	>, 05	3,512	p <, 05	-1,087	p>, 05	,-1,951	p>, 05
Task-ready information technology readiness	0,373	>, 05	2,824	p <, 05	-0, 772	p>, 05	0,560	p>, 05
Institutional support readiness	0,818	>, 05	2,199	p >, 0.	-0, 775	p>, 05	0,66	p>, 05

Internet Access: When the participants' access to the Internet was examined, it was seen that 85.3% of them provided internet access via personal mobile devices. It is not surprising that these people in the full-time workforce provide internet access with more mobile devices. They use the internet connection in their homes *by* 70.6%. And 54.9% of them use the connection provided by the workplace, 6.9% of them use wi-fi hotspots, 3.9% of them use the internet and 2% of them use internet café.

5.2. Readiness Dimensions

The quantitative data analysis addresses the level of readiness for nurses in each dimension and identifies critical factors that need to be considered to determine a successful IT for the e-learning level. The level of readiness in each dimension was assessed individually. Readiness Dimensions Levels are shown in Table 3.

Table.3 Readiness Dimensions Levels

Readiness Dimensions	**Readiness Level(%)**
Technological skills	76,6
Attitude readiness	73,4
Task-ready information technology	77
Institutional support	73

Technological skills readiness dimension: When the results of the descriptive analysis of technological skill dimensions and items were examined, it was seen that the participants have an average score of 3.83 (76,6 %). This score indicates that the participants were skilled in technology and mostly use mobile devices.

Attitude readiness dimension: When the results were examined, it was seen that the participants have an average score of 3.67 (73,4 %). In other words, the attitudes of the participants towards information technologies are positive. Most participants are aware of the usefulness of information technologies in professional life and use them.

Task-ready information technology readiness: When the results of task-ready information technology readiness were analyzed, it was seen that nurses have a score of 3.85 (77%). It can be seen that participants are quite open to new technologies.

Institutional support readiness dimension: When the results were examined, it was seen that the participants have an average score of 3.65 (73 %). This means that the participants expect support from their institutions.

5.3. Relationship Between Dimensions

When the Pearson correlation analysis results were examined to determine the relationships between the dimensions, the following results were found (Table4):

Table 4. Results of Pearson Correlation Analysis for Relationships Between Dimensions

	A- Technological Skills readiness	B- Attitude readiness	C- Task-ready information technology readiness	D- Institutional support readiness
A- Technological Skills readiness				
B- Attitude readiness	,359*			
C-Task-ready information technology readiness	,510*	,556*		
D- Institutional support readiness	,110	,350*	,461*	

* p < ,01

- There is a significant and positive correlation between the dimensions of technological skills and attitude readiness, task-ready information technology readiness dimensions (r = 359, p <, 01). Thus, when the technological skill increases, attitude readiness, and task-ready information technology readiness increase.
- On the other hand, no significant correlation was found between the technological skill dimension and institutional support readiness (r =, 110, p>, 05).
- There is a significant and positive correlation between the attitudes readiness, task-ready information technology readiness and institutional support readiness, respectively (r =, 556,

350, p <, 01). Accordingly, when the readiness of the altitude increases, it can be said that the task-ready information technology readiness and the institutional support readiness increase.

- There is a significant and positive correlation between the institutional support readiness and the task-ready information technology readiness (r =, 461, p <, 01). Accordingly, it can be said that when the task-ready information technology readiness increases the institutional support readiness increases.

6. Discussion

6.1. Demographic Information Evaluation

In this study, the relationships between the demographic information of the participants and the readiness of information technologies were examined. When the participants' access to the Internet was examined, it was seen nurses use computers and mobile devices (smartphones, tablets, laptops) without problems when connecting to the internet. Therefore, the fact that the mobile technology trend shown here can be reflected in the works will bring great benefits [20].

When the demographics were participants in the 25-year age group had significantly higher technological skills and attitude readiness. But Cakir and Horzum [21], who investigated that online learning was not affected by the participant age. Indeed, this finding is not supported by most studies. Pillay et al.in their study found that participants over the age of 40 have technical competence in online learning was significantly lower than in other participants [22]. This judgment is consistent with the finding that those over the age of 36 show lower information technology readiness. However, it can be seen in the literature that technical competence and computer adequacy are rather low in individuals older than 40 years, rather than a linear decrease with age. Fogerson [23] stated that online learning readiness increased with age. Therefore, individuals who are mentally mature and have knowledge accumulate are more inclined to use information technologies. However, individuals over 40 years of age do not have sufficient skills in general.

When the educational status is considered, it is seen that the level of the education level of the participant does not affect any information technology readiness dimension. However, it can be said that this data is not meaningful if it is taken into account that the participants of the study are not persons with lower education levels. However, it was found that undergraduate or associate degree did not make any difference in this context.

According to the independent sample t-test results, the marital status, which is the last demographic characteristic examined, does not affect any of the information technology readiness dimensions.

6.2. Readiness Dimensions

In the study, information technology readiness was examined in four different dimensions: technological skills, attitude readiness, information technology preparedness for the task and readiness of institutional support. When the relations between these dimensions are examined, it is seen that there are positive correlations between technical skills and attitude readiness and teask-ready information technology readiness for the job. Accordingly, when the technological skills readiness of the participants' increases, attitudes and attitudes towards the task are increasing. Also, there is a positive correlation between attitude readiness and teask-ready information technology readiness for the task and the readiness for institutional support. Accordingly, when the readiness of the participants increased,

task-ready information technology readiness and institutional support readiness increased. Finally, a positive correlation was found between the readiness of task-ready information technology readiness and institutional support readiness. Accordingly, it can be said that when the readiness of task-ready information technologies increased, the institutional support readiness increased. When the average scores of the participants' four dimensions were examined, it was found that these scores were above the expected readiness limit (3.40) determined by Aydın and Taşcı [17] and therefore the information technology readiness of the participants was high. The level of technological skills readiness was 3.83 (76,6 %) and ready but needs a few improvements for readiness. The level of attitude readiness was 3.67 (73,4 %) and ready but needs a few improvements for readiness. The level of task-ready information technology readiness nurses was ready at 3.85 (77%) and ready but needs a few improvements for readiness. The institutional support readiness was 3.65 (73 %) indicating ready but needs a few improvements for readiness. When the information technology readiness was analyzed totally, it was seen that there has been a significant and positive correlation among readiness dimensions.

7. Conclusion

With this study, four dimensions of IT readiness were identified to measure readiness that had been derived from the literature review. These dimensions were categorized as technological skills readiness, attitude readiness, task-ready information technology readiness and institutional support readiness to determine the IT readiness level of nurses. According to the results, it was seen that the participants' information technology readiness did not differ significantly according to their gender, educational status, and marital status. On the other hand, it was found that the technological skills and attitude readiness of the participants under the age of 25 were significantly higher than the participants over the age of 36 years. According to the results, the average value of the information technology readiness is 3.75 (75 %) and the nurses can reach a much better level with less personal effort and needs a few improvements for readiness.

References

[1] Eley R, Fallon T, Soar J, Buikstra E, Hegney D. "The Status of Training and Education in Information and Computer Technology of Australian Nurses: A National Survey", *Journal of Clinical Nursing*, 17(20), 2758-2767, 2008.

[2] Sinsky, C. A., Willard-Grace, R., Schutzbank, A. M., Sinsky, T. A., Margolius, D., Bodenheimer, T. "In search of joy in practice: A report of 23 high-functioning primary care practices", *Annals of Family Medicine*, 11(3), 272-278. http://dx.doi.org/10.1370/afm.1531, 2013.

[3] Kaya, N., Aştı, T. "Sağlık Bakımında Bilgisayar Kullanımına Yönelik Tutum Ölçeğinin Güvenirlik ve Geçerliği", *İstanbul Üniversitesi Florence Nightingale Hemşirelik Yüksekokulu Dergisi*., 16(61), 24-32, 2008.

[4] Jaeger, F. N., Bechir, M., Harouna, M., Moto, D. D., Utzinger, J. "Challenges and opportunities for healthcare workers in a rural district of Chad", *BMC health services research*, 18(1), 7. doi:10.1186/s12913-017-2799-6C, 2018.

[5] Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Haines, A. "The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review", *PLoS medicine*, 10(1), e1001362. doi:10.1371/journal.pmed.1001362, 2013.

[6] Bowles, K. H., Dykes, P., Demiris, G. "The use of health information technology to improve care and outcomes for older adults", *Research In Gerontological Nursing*, 8(1), 5–10. doi:10.3928/19404921-20121222-01, 2015.

[7] Matthew-Maich, N., Harris, L., Ploeg, J., Markle-Reid, M., Valaitis, R., Ibrahim, S.,Isaacs, S. "Designing, Implementing, and Evaluating Mobile Health Technologies for Managing Chronic Conditions in Older Adults: A Scoping Review", *JMIR mHealth and uHealth*, 4(2), e29. doi:10.2196/mhealth.5127, 2016.

[8] Janice, P.L On the move with mHealth: Nurses develop mobile health tools. https://www.nurse.com/blog/2015/11/09/on-the-move-with-mhealth-nurses-develop-mobile-health-tools/

[9] Austin. R., Hull, S. "The Power of Mobile Health Technologies and Prescribing Apps", *CIN: Computers, Informatics, and Nursing*, 32(11). 513-515, 2014.

[10] Cobb, C., Sudar, S., Reiter, N., Anderson, R., Roesner, F., Kohno, T. Computer." Computer security for data collection technologies", Conference on Information and Communication Technologies and Development, 2016.

[11] Farmer, R. "The Rise of Mobile Health Apps, Minority and Community Health, Nurse Health. 2015

[12] S. F. Ellen, P. H. Pixita, and E. M. Susan, "Collaborating to Cross the Mathematics–Literacy Divide: An Annotated Bibliography of Literacy Strategies for Mathematics Classrooms", *Journal of Adolescent& Adult Literacy*, 55 (1): 57–66, 2011.

[13] Holt, D. T, Vardaman, J. M. "Toward a comprehensive understanding of readiness for change: The case for an expanded conceptualization", *Journal of Change Management*,13(1), 9-18. http://dx.doi.org/10.1080/14697017.2013.768426 ICTD '16. ACM, New York, NY, USA. 2:1–2:11, 2013.

[14] Kaya, N. "Factors Affecting Nurses' Attitudes Toward Computers in Healthcare", *Computers Informatics Nursing.* 29(2), 121-129, 2011.

[15] Nyoni, J. "E-readiness of Open and Distance Learning (ODL) Facilitators: Implications for Effective Mediation", *Perspectives in Education*, 32(3), 78-91, 2014.

[16] Saekow, A., Samson, D. "E-learning Readiness of Thailand's Universities Comparing to the USA's Cases", *International Journal of e-Education, e-Business, e-Management and e-Learning*, 1(2): 126-131, 2011.

[17] Aydın, C. H., Taşçı. D. "Measuring Readiness for e-Learning: Reflections from an Emerging Country", *Educational Technology & Society*, 8(4), 244-257, 2005.

[18] Caison, A.L., Bulman D., Pai S., Neville, D. "Exploring the technology readiness of nursing and medical students at a Canadian University", *Journal of Interprofessional Care*, 22(3): 283–294,2008.

[19] Joo, Y. J., Joung S., Sim W. J. "Structural relationships among internal locus of control, institutional support, flow, and learner persistence in cyber universities", *Computers in Human Behavior*, 27(2), 714-722, 2011.

[20] Şahin, G., Başak, T." Mobile Learning in Nursing "M-Learning", *Journal of Human Sciences*, 14(3), 2017.

[21] Çakır, Ö., Horzum, M. B. "Öğretmen Adaylarının Çevrimiçi Öğrenmeye Hazır Bulunuşluk Düzeylerinin Çeşitli Değişkenler Açısından İncelenmesi", *Eğitimde Kuram ve Uygulama*. 11(1), 1-15, 2015.

[22] Pillay, H., Irving, K., Tones, M. "Validation of the Diagnostic Tool for AssessingTertiary Students' Readiness for Online Learning", *Higher Education Research & Development*, (2), 217-234,26, 2007.

[23] Fogerson, D. L. "Readiness Factors Contributing to Participant Satisfaction in Online Higher Education Courses", Doctoral Dissertations, Knoxville: University of Tennessee, 2005.

[24] Kaya H, Işık B, Bodur G. "The relationship between in-service training nurses' attitudes toward computer in health care and computer anxiety in Turkey", *International Journal of Human Sciences.* 11(2):948- 963, 2014.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.03

IJHSRP

Research Article

EVALUATION OF BED UTILIZATION PERFORMANCE OF HOSPITAL DEPARTMENTS IN TURKEY WITH GREY RELATIONAL ANALYSIS

Arzu YİĞİT
Süleyman Demirel University, Faculty of Economics and Administrative Sciences, Department of Health Management, Isparta, Turkey
arzuyigit@sdu.edu.tr

Abstract: *This study aimed to analyze the bed utilization performance of hospital departments in Turkey with the grey relational method. Grey relational analysis was used to determine the bed utilization performance levels of surgery and internal clinics in Turkey. In this study, hospital performance indicators are used as variables; bed occupancy rate, bed turnover rate and the average length of stay. Research data were obtained from the Statistical Report of Public Hospitals Unions. Data were analyzed using MS Excel, SPSS 18 software. In this study, bed occupancy rate (BOR), the average length of stay (ALS) and bed turnover rate (BTR) performance indicators of clinics were found to be 67.3; 5.6 and 63.4, respectively. According to the grey relational analysis (GRA), the section with the most desirable characteristics represents the sections with the highest scores. The highest grey relational grade score was found to be obstetrics and gynecology (0.904) and the lowest score of skin and venereal diseases (0.474) departments. In the multidimensional analysis, it was evaluated in two categories as efficient and inefficient in evaluating the bed use performance of departments. Hospitals are the most resource-consuming element of a health care system. The hospital's bed utilization performance has a positive impact on the hospital's financial success. A significant portion of the cost of operating in hospitals is due to unnecessary patient hospitalization. To reduce hospital costs, patient beds need to be used optimally. Hence, hospital managers should regularly audit bed utilization.*

Keywords*: Hospital, Bed Utilization, Performance, Grey Related Analysis*

Received: September 22, 2019 Accepted: November 30, 2019

1. Introduction

Bed utilization one of the most important indicators of hospital performance, accurate measurement of performance is very important in managing resources effectively and efficiently. Hospital bed utilization is influenced by various factors, which may be categorized into patient-related, physician-related, administration-related issues [1] and there is a multitude of factors that affect the demand for beds in various medical services [2]. Performance indicators for hospitals are important for management to evaluate and improve various hospital functions [3].

Bed management is the assignment and provision of beds, especially in a hospital where beds in specialist wards are scarce resources. Managing beds might seem like a simple task but bed management involves the continuous monitoring of hospital admissions, discharges and hospital utilization indices to identify vacant beds across wards [4].

Limited healthcare resources in low- and middle-income countries have led policy-makers to improve healthcare efficiency [5]. Scarce healthcare resources require carefully made policies ensuring

optimal bed allocation, quality healthcare service, and adequate financial support [6]. Optimal utilization of hospital beds is very important. Non-availability of hospital beds can shed a negative light on the image of the hospital [4]. Efficiency and performance show how well an organization uses existing resources [7]. Performance evaluation in hospitals is a process related to the evaluation, measurement, and implementation of performance in a certain period of time [8]. Performance evaluation provides useful information to hospital managers on issues related to the evaluation and monitoring of the current situation and activities.

Capacity utilization level in the evaluation of performance and cost monitoring in hospitals provides information to hospital managers. Capacity utilization rate is one of the main performance indicators in hospitals [9]. Capacity planning is central to the pursuit of balancing the quality of health care delivered with the cost of providing that care [10].

Performance measurement is highly essential for hospitals, where efficiency is a vital indicator. To measure the performance of hospitals, several hospital performance assessment methods have been proposed in the literature which among them the grey relational analysis.

2. Materials and Method

This study aimed to analyze the bed utilization performance of hospital departments with Grey relational method. The population of the study consists of 18 hospital departments affiliated to the Union of Public Hospital in Turkey. The data of the study cover the period from January 2017 to December 2017. Research data were obtained from the Statistical Report of Public Hospitals Unions [11]. The data of the study were analyzed via MS. Office Excel and SPSS 18 statistics software.

The performance criteria used in the study are as follows: BOR, BTR, and ALS. In this paper, it was assumed that all metrics had the same importance and used the same value for each sequence in the GRA. Also, a multidimensional analysis of bed utilization performance criteria was performed. It was analyzed with a scatter diagram to determine the relationship between bed usage performance indicators. In the multidimensional analysis, evaluating the bed use performance of clinics was evaluated in two categories as efficient and inefficient. Therefore, BTR's minimum, BOR's minimum and ALS maximum value that the departments are inefficient. BTR has a maximum, BOR has a maximum and ALS has a minimum means that the departments are efficient.

GRA theory, a method of decision making and analysis developed by Judong Deng in 1982. The grey system method has been extensively applied in various fields [12]. GRA is used to identify the grey relational grade among various indicators and to select the most representative one [13]. GRA is an important classification, grading and decision making method that can be used to solve multi-criteria decision-making problems. The goal of grey system theory is to bridge the gap between the natural sciences and the social sciences [14].

In grey system theory, white refers to known information, black refers to unknown information, and the grey area in between refers to partially known information. Grey methods have the powerful advantage of being capable of dealing with complex problems concerning uncertain [15]. Grey system theory is a method used in the application of parametric statistical analysis methods where various assumptions such as homogeneity of variances, the distribution of the data to be applied are suitable for normal distribution and, for example, sufficient size are not valid [16]. GRA is a method of use in enterprise performance evaluation. GRA is an effective method for decision problems where there are

complex relations between criteria. The grey relation covers the evaluation of the relationship between two or more parameters or elements within a system. In order to compare the alternatives with the GRA method, a calculation consisting of six steps is performed. The formula used in these steps is given in Table 1 [17-19].

Table 1. Calculation steps of grey relational analysis

Step	Definition	Formula	
1	Preparation of data and formation of decision matrix. Consisting of the number of units (m) and the number of variables (n)	$x_i = (x_i(1),\ x_i(2),\ x_i(3), \dots, x_i(k))$ $k = 1,2,3, \dots, n \ ve \ i = 1,2,3, \dots, m$	1
2	Creation of reference series and comparison matrix.	$x_0 = (x_0(k))$ k=1,2,…,n	2
3	Normalization process and obtaining normalized matrix. Of these formulas; formula (3.1) is used to convert benefit, formula (3.2) is used to convert cost and formula (3.3) is used to convert average type criterion values to standard values.	$x_i(k) = \frac{x_i^{(0)}(k) - \min x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)}$	3.1
		$x_i(k) = \frac{max\ x_i^{(0)}(k) - x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)}$	3.2
		$x_i(k) = 1 - \frac{x_i^{(0)}(k) - x^0}{\max x_i^{(0)}(k) - x^0}$	3.3
4	Creating the absolute value table	$\Delta x_i(k) = \lvert x_0(k) - x_i(k) \rvert$	4
5	Calculating the grey relational coefficient	$\gamma x_0(k), x_i^* = \frac{\Delta\min + \zeta\Delta\max}{\Delta_{0i}(k) + \zeta\Delta\max}$ Where $\gamma\ x_0(k)$ – Ideal sequence ($x_0(k) = 1,\ k = 1,2\dots$) Δ min – Smallest value of $\Delta_{0i}(k)$, Δ max – Largest value of $\Delta_{0i}(k)$, $\Delta_{0i}(k)$– difference of absolute value between $x_0(k)$ and $x_i^*(k)$, $\Delta\ 0_i(k) = x_0(k) - x_i^*(k)$, ζ – Distinguishing coefficient (between 0 and 1), If all the process parameters have equal weightage then ζ is set to be 0.5.	5
6	Calculating the grey relational degree r_{0i} indicates the grey relational degree (6.2). If weight is to be applied to evaluation criteria, the formula will be as (6.2)	$r_{0i} = \frac{1}{n}\sum_{k=1}^{n} \gamma(x_0(k), x_i(k))$	6.1
		$r_{0i} = \sum_{k=1}^{n} [w_i(k) * (x_0(k), x_i(k))]$ Weight values for criteria (w_k) totals must be 1. The decision alternative with the highest grey relational degree value is determined as the best alternative.	6.2

3. Results

Hospital bed performance indicators of departments in which BOR, ALS, BRT findings are given in Table 2. The data on the bed performance indicators of the surgical and internal departments of hospitals affiliated to the Ministry of Health in Turkey is given in Table 2. BOR, ALS and BRT performance indicators of clinics were found to be 67.3; 5.6 and 63.4 respectively. As can be seen in Table 1, the clinical physical medicine and rehabilitation with the highest value in terms of BOR (80%) and the clinical skin and venereal diseases with the lowest value (33%) were found. ALS was found to be the highest value in terms of performance indicator mental health and diseases (18 days) and the lowest value in terms of Clinical Pediatric Surgery (2.0). In terms of the BRT performance indicator, the highest value was clinical obstetrics and gynecology (123.9) and the lowest value was mental health and diseases (14.4). A reference series needs to be created in order to be able to perform grey relational analysis. The reference values to be determined in the first step in accordance with the research methodology were determined in Table 2.

Table 2. Dataset and reference values of hospitals performance criteria

Departments Name	BOR	ALS	BTR
Brain and Neurosurgery	72.5	5.2	50.5
Pediatric Surgery	68.7	2.0	123.1
Child Health and Diseases	62.1	3.2	71.1
Skin and Venereal Diseases	32.9	4.7	25.6
Physical Medicine and Rehabilitation	79.6	16.5	17.6
General Surgery	69.1	3.3	76.4
Chest Surgery	62.0	5.8	39.2
Chest Diseases	79.4	7.3	39.7
Eye Diseases	55.7	1.6	123.8
Internal Medicine	66.3	5.1	47.2
Obstetrics and Gynecology	72.5	2.1	123.9
Cardiovascular Surgery	69.5	5.3	47.9
Cardiology	68.9	3.6	69.0
Neurology	65.9	6.1	39.3
Orthopedics and Traumatology	77.5	4.9	58.3
Plastic and Reconstructive Surgery	67.0	2.9	83.3
Mental Health and Diseases	73.2	18.5	14.4
Urology	69.0	2.8	90.0
Reference	79.6	1.6	123.9
Minimum	32.9	1.6	14.4
Maximum	79.6	18.5	123.9
Mean	67.3	5.6	63.4
Standard deviation	10.522	4.612	34.799

It is difficult to compare the different kinds of factors because they exert a different influence. Therefore, the standardized transformation of these factors must be done. After the values in the decision matrix are arranged, the decision matrix is normalized by using the equality in the materials and methods section. At this stage, a normalization process has been carried out to ensure that the alternatives are comparable so that they can be stripped of their units and their size drawn to lower levels. The normalized decision matrix is shown in Table 3. After the normalized decision matrix is obtained, the differences between the normalized values of the reference series and the normalized values in the matrix are calculated. The difference matrix consisting of calculated values is shown in Table 3.

The elements of the grey relational coefficient matrix were calculated for maximum and minimum values among all criteria. The values of Δ_{max} and Δ_{min} calculated in the difference data sequence used for the calculation of grey relational data are given below. The parameter ζ is 0.5 as in many studies in the literature [17-19]. The grey relational coefficient matrix obtained from the calculations is shown in Table 3.

Table 3. Normalized Decision and Absolute Matrix

	Normalized values			**Absolute value**		
Departments Name	BOR	ALS	BTR	BOR	ALS	BTR
Brain and Neurosurgery	0.848	0.787	0.330	0.152	0.213	0.670
Pediatric Surgery	0.767	0.976	0.993	0.233	0.024	0.007
Child Health and diseases	0.625	0.905	0.518	0.375	0.095	0.482
Skin and Venereal Diseases	0.000	0.817	0.102	1.000	0.183	0.898
Physical Med. and Rehabilitation	**1.000**	0.118	0.029	**0.000**	0.882	0.971
General Surgery	0.775	0.899	0.566	0.225	0.101	0.434
Chest Surgery	0.623	0.751	0.226	0.377	0.249	0.774
Chest Diseases	0.996	0.663	0.231	0.004	0.337	0.769
Eye Diseases	0.488	**1.000**	0.999	0.512	**0.000**	0.001
Internal Medicine	0.715	0.793	0.300	0.285	0.207	0.700
Obstetrics and Gynecology	0.848	0.970	**1.000**	0.152	0.030	**0.000**
Cardiovascular Surgery	0.784	0.781	0.306	0.216	0.219	0.694
Cardiology	0.771	0.882	0.499	0.229	0.118	0.501
Neurology	0.707	0.734	0.227	0.293	0.266	0.773
Orthopedics and Traumatology	0.955	0.805	0.401	0.045	0.195	0.599
Plastic and Reconstructive Surgery	0.730	0.923	0.629	0.270	0.077	0.371
Mental health and diseases	0.863	0.000	0.000	0.137	1.000	1.000
Urology	0.773	0.929	0.690	0.227	0.071	0.310
Reference	**1.000**	**1.000**	**1.000**			
Δ_{max}				1.000		
Δ_{min}				0.000		
ζ				0.500		

Once the absolute matrix is obtained, the grey relational coefficient matrix is formed. There are two different situations in which the criteria are of equal and different weight in the evaluation of the grey relational coefficient matrix. In this study, the criteria were assumed to be of equal importance.

In this step, the grey relational coefficient was calculated and based on this coefficient, the grey relational degree was found. The reason why the variables used in this research are equally weighted is that there is no information about which of these variables is superior in the literature. The findings are given in Table 3. According to the bed usage performance indicators, the sections with the highest grey relational grade were determined. In the last step, the scores obtained as a result of the GRA and the ranking of the internal and surgical clinics were performed. According to the grey relational analysis, the section with the most desirable characteristics represents the sections with the highest scores. The highest grey relational grade score was found to be obstetrics and gynecology (0.904) and the lowest score was skin and venereal diseases (0.474) departments.

Table 4. Grey relational coefficient matrix, grey relational degrees and sorting

	Grey Relational Data (criteria equal-weighted)			Grey Relational	
Departments Name	BOR	ALS	BTR	Degree	Ranking
Brain and Neurosurgery	0.767	0.701	0.427	0.632	11
Pediatric Surgery	0.682	0.955	0.986	0.874	2
Child Health and Diseases	0.572	0.841	0.509	0.640	10
Skin and Venereal Diseases	0.333	0.732	0.358	0.474	18
Physical Medicine and Rehabilitation	1.000	0.362	0.340	0.567	14
General Surgery	0.690	0.833	0.535	0.686	7
Chest Surgery	0.570	0.668	0.393	0.544	16
Chest Diseases	0.992	0.597	0.394	0.661	9
Eye Diseases	0.494	1.000	0.998	0.831	3
Internal Medicine	0.637	0.707	0.417	0.587	13
Obstetrics and Gynecology	0.767	0.944	1.000	0.904	1
Cardiovascular Surgery	0.698	0.695	0.419	0.604	12
Cardiology	0.686	0.809	0.499	0.665	8
Neurology	0.630	0.653	0.393	0.559	15
Orthopedics and Traumatology	0.917	0.719	0.455	0.697	5
Plastic and Reconstructive Surgery	0.650	0.867	0.574	0.697	6
Mental health and diseases	0.785	0.333	0.333	0.484	17
Urology	0.688	0.876	0.618	0.727	4

In addition, the multidimensional analysis of bed utilization performance criteria was performed. It was analyzed with a scatter diagram to determine the relationship between bed usage performance indicators. A multidimensional scattering graph of bed performance indicators and grey relational analysis results are given in Figure 1.

In this study, based on the data obtained from the GRA method, the bed use performance of the clinics was evaluated by multidimensional analysis. Bed utilization performance of clinics was evaluated in two categories as efficient and inefficient. The findings from the GRA was divided into four regions according to the bed use performance of the clinics by a multidimensional scattering graph.

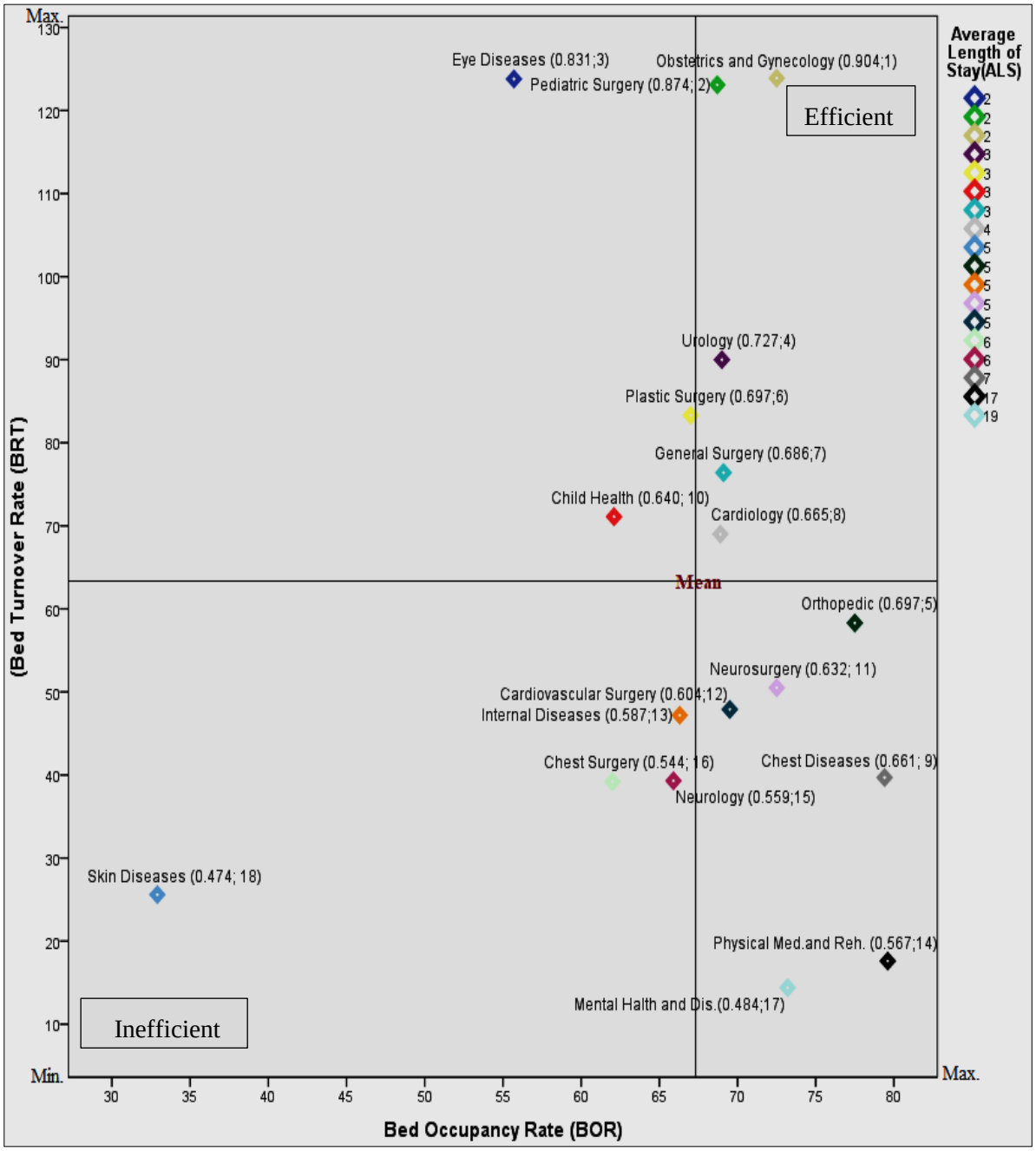


Figure 1. Multidimensional scattering graph of bed performance indicators

Similar results were obtained when GRA and Multidimensional scattering graphs were compared. According to the results of both methods, the most productive department was found to be obstetrics and Gynecology and the most inefficient department was skin diseases.

4. Discussion

A significant portion of the cost in hospitals is due to poor management of patient beds [22]. Reducing the costs of use in hospitals is very important. BOR, BRT, and ALS is an important parameter in assessing hospital bed performance. BOR and BTR that high rate indicates are used efficiently, while the low rate indicates that the patient beds are used inefficiently. ALS is efficient being low, while a high is regarded as inefficient [20].

In this context, the most efficient department was obstetrics and gynecology while the most inefficient department was the skin diseases clinic. Mental health and physical medicine departments BOR and ALS are high. The eye and pediatric surgical departments BRT are high, the mean ALS has been found to be low, but the BOR is below average. The results indicate that although six clinics have an outstanding performance, four clinics exhibited poor performance and eight clinics were found to have moderate performance (Figure 1). In this study, hospital bed use performance was different according to departments. There are many reasons for this condition. The most important reason is that some diseases are treated in a short period of time and some are treated in a long period of time. For example, while mental health diseases are treated in hospital in a long time, in obstetrics, patients are treated in a very short time. The departments can take place in different regions in Figure 1 because of their unique characteristics.

In this study, hospital bed use performance was different according to departments. There are many reasons for this condition. The most important reason is that some diseases are treated in a short period of time and some are treated in a long period of time. For example, in mental health and disease patients are treated in hospital for a long time, while in obstetrics, patients are discharged in a very short time. Because of the unique characteristics of the clinics, they can be located in different regions in Figure 1.

Decision-making approaches in health services aim to select the most appropriate alternatives by evaluating many conflicting criteria together. The main reason for determining the performance levels of hospital clinics is to prevent waste of resources during the hospitalization process [21]. There are many academic studies on bed use performance in Turkey. These studies were usually done with the Pabon Lasso model [20, 22-24]. Pabon Lasso model developed by Pabón Lasso (1986), is a graphical technique that uses bed occupancy rate, bed turnover rate and the average length of stay indicators to measure relative hospital performance [25]. This model is considered to be an alternative method that makes it possible to measure performance with a simple graph and is easier to understand than other performance measurement models [26]. Bed use efficiency is considered as one of the most important performance indicators in evaluating performance in hospitals and monitoring costs [9]. Appropriate utilization of beds allocated for a particular department will help to increase the efficiency of the discharge process. It is recommended that bed utilization indices be used routinely to assess, analyze and improve the available resources [4]. Using the beds of public hospitals in the same province or region in terms of efficient use of public resources will have a positive impact on the financial sustainability of both the university and the ministry of health hospitals [27].

In a study evaluating hospital bed use performance in Turkey, it was found that 23% of clinics performed very well, while 18% had very low productivity [20]. In Turkey, 25% of hospitals affiliated with the Ministry of Health were found to be performing good bed use [23]. The bed occupancy rate, bed turnover rate and stay day averages of universities and hospitals in Turkey increased in 2017

compared to 2014. Analysis of productivity found that while 18% of hospitals were in the most efficient region in 2014, this figure rose to 29% in 2017 [28]. In a study analyzing hospital bed performance in Iran; the overall ALS, BOR and BTR rates were 4.1 days, 68.9% and 61.1 respectively[29]. Health centers and hospitals bed performance in Uganda, the average indicators ALS; 3.63 days, BTO; 74.0 times per year and BOR; 49.3% were obtained.

5. Conclusions and Recommendations

Hospitals make up a significant share of health spending, and inefficient use of patient beds directly increases hospital costs. Hence, in order to provide quality, efficient and cost-effective health care, and bed performance should be evaluated regularly by hospital managers. The Ministry of Health should take into consideration the situation of physicians and nurses when planning beds in hospitals in Turkey. Hospital managers should also consider bed usage performance indicators while allocating beds to departments.

One of the most important problems with bed use in hospitals is unnecessary hospitalization. Therefore, it is recommended to prepare treatment protocols to prevent unnecessary hospitalizations in hospitals. A hospital has to manage the beds of all its clinics effectively according to supply and demand. Hospitals allocate a certain number of beds to clinics. However, the application to the relevant clinic is more or less during the year. While the bed occupancy rate of one clinic of the hospital is high, other clinics are sometimes less than the demand. In order to reduce inpatient costs, the average length of hospitalization should be shortened.

GRA is one of the most common techniques used in recent years as a guide to the solution of multi-criteria decision-making problems. GRA can evaluate the activities of hospitals and their bed use performance, identify potential inefficiencies related to bed use of hospitals and conduct performance rankings. It is therefore recommended that this method be used frequently in decision-making stages in hospitals. The reasons for the inefficiency of inefficient departments should be identified and strategies should be developed to make them efficient. The efficiency scores of the departments indicate how close they are to use their maximum bearing performance capacities. Therefore, it is recommended that inefficient departments should be reduced in the number of beds and concentrate on outpatient services. In order to determine the performance of hospital beds in more detail, it is recommended to researchers using Data Envelopment Analysis (DEA) method which includes efficiency.

References

[1] Kanwar, V., Gupta. A.K., Goel, S., Gupta. P.D., “Hospital bed utilization : perceptions of healthcare practitioners”, *International Journal of Hospital Research,* 4 (3), 113–118, 2015.

[2] Kao, E. P. C., Tung, G.G., “Bed allocation in a public health care delivery system”, *Management Science,* 27(5),507–520, 1981.

[3] Ajlouni, M.M., Zyoud, A., Jaber, B., et al., “The relative efficiency of Jordanian public hospitals using data envelopment analysis and pabon lasso diagram”, *Global Journal of Business Research,* 7(2),59–73, 2013.

[4] Banu, N., Ashok, L., Malarout, N., et al., “Study of bed allocation and utilization in a tertiary care teaching hospital in Indian”, *Journal of Public Health Research & Development*, 9(8), 143-

48, 2018.

[5] Hafidz, F., Ensor, T., Tubeuf, S., "Efficiency measurement in health facilities: a systematic review in low- and middle-income countries", *Applied Health Economics and Health Policy* 16(4), 465–80, 2018.

[6] Belciug, S., Gorunescu, F., "Improving hospital bed occupancy and resource utilization through queuing modeling and evolutionary computation", *Journal of Biomedical Informatics*, 53, 261-69, 2015.

[7] Kavuncubaşı, Ş., Ersoy K,. "Technical efficiency measurement in hospitals", *Journal of Public Administration,* 28, 77-92, 1995.

[8] Hosseini, S.E., Ebrahimipour. H., Badiee. S., et al. "Performance evaluation of Mashhad University of medical sciences hospitals during 2006-2011 : Application of pabon lasso model", *Jentashapir J Heal Res*, 7(4),1-6, 2016.

[9] Yiğit, V., Ağırbaş İ., "Effect of capacity use ratio on costs in hospitals: An application in the Ministry of Health Tokat Maternity and Child Care Hospital", *Journal of Hacettepe Health Administration,* 7 (2), 141-162, 2004.

[10] Akcali, E., Cote, M. J., Lin, C., "A network flow approach to optimizing hospital bed capacity decisions", *Health Care Management Science*, 9, 391-404, 2016.

[11] Ministry of Health, Public Hospitals Statistics Report, The General Directorate of Public Hospitals, Statistics, Analysis, Reporting And Strategic Management Department, 2017.

[12] Lin, C., Wu, C., Chen, H., "Selecting the location of hospitals in Taiwan to ensure a competitive advantage via GRA", *The Journal of Grey System*, 3, 263–274, 2006.

[13] Wang, S., Ma Q, Guan, Z., "Measuring hospital efficiency in China using grey relational analysis and data envelopment analysis". Proceedings of 2007 IEEE International Conference on Grey Systems and Intelligent Services, pp. 135–139, 2007.

[14] Julong, D., "Introduction to grey system theory". The Journal of Grey System, 1(1), 1-24, 1989.

[15] Hsiao, S.W., Tsai, H.C., "Use of gray system theory in product-color planning". *Color Research & Application*, 3(29), 222–31, 2004.

[16] Yağanoğlu, A.M., Grey Relational Analysis and Fuzzy System Theory Use in Livestock. Atatürk University Graduate School of Natural and Applied Sciences Department of Animal Science Department of Biometer and Genetics, 2017.

[17] Wu, H.H., "A comparative study of using grey relational analysis in multiple attribute decision-making problems", *Quality Engineering*, 15(2), 209-217, 2002.

[18] Zhai, L.Y., Khoo, L.P., Zhong Z.W., "Design concept evaluation in product development using rough sets and grey relation analysis", *Expert Systems with Applications*, 36(3),7072–7079, 2009.

[19] Chan, J.W.K., Ton, T.K.L., "Multi-criteria material selections and end-of-life product strategy: Grey relational analysis approach". *Materials and Design*, 28(5), 1539–1546, 2007

[20] Yiğit, V., "Analysis of clinical bed utilization effectiveness in hospitals with pabón lasso model", *International Journal of Health Management and Strategies Research*, 3 (1), 64-174, 2017.

[21] Yiğit, V., "Technical efficiency analysis in hospitals: An application of public hospitals association", *Journal of SDU Health Sciences Institute*, 7 (2), 9–16, 2016.

[22] Yiğit, V., Esen H., "Performance measurement in hospitals with pabon lasso model and data envelopment analysis, *SDU Journal of SDU Health Sciences Institute*, 8 (2), 26-32, 2017.

[23] Çalışkan, Z., "Analysis of public hospital unions performance with pabón lasso model", *Journal of Social Security*, 10, 1-24, 2017.

[24] Yıldız, M.S., "Evaluation of hospital bed utilization for 2002-2015 in Turkey: an implementation of pabon lasso methodology", *Journal of Hacettepe Health Administration*, 20(3), 347-356, 2017.

[25] Imamgholi, S., Khatami Firouzabadi, S. M. A., Goharinezhad, S., et al., "Assessing the efficiency of hospitals by using pabon lasso graphic model", *Journal of Research and Health*, 4(4), 890-897.2014.

[26] Aeenparast, A., Farzadi, F., Maftoon, F., Zandian, H.,Rezaei Yazdeli, M. "Quality of hospital bed performance studies based on pabon lasso model". *International Journal of Hospital Research*, 4(3), 143-148, 2015.

[27] Yiğit, V., Yiğit, A., "Financial sustainability of university hospitals" *Mehmet Akif Ersoy University Journal of Social Sciences Institute*, 8(16), 253-273, 2016.

[28] Taşkaya, S., Evaluation of the efficiency of the hospitals jointly used by the ministry of health and universities with pabon lasso model, *Hacettepe Journal of Health Administration*, 22(3), 559-576, 2019.

[29] Kalhor, R., Salehi, A., Keshavarz, A., Bastani, P.,Heidari Orojloo, P., Assessing hospital performance in Iran using the pabon lasso model. *Asia Pacific Journal of Health Management,* 9 (2);77-82, 2014.

[30] Nabukeera, M., Boerhannoeddin, A., Raja Noriza,RA.An evaluation of health centers and hospital efficiency in Kampala capital city authority Uganda; using pabon lasso technique. *Journal of Health and Translational Medicine*, 18(1), 12-17, 2015.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.04

IJHSRP

Research Article

RISKS ANALYSIS IN CATERING INDUSTRY

***Tolga Ankaraligil**[1], **Ayşe Özdemir** [2]

[1]Uşak University, Graduate School of Natural and Applied Sciences, Occupational Health and Safety Department, Uşak/TURKEY
[2]Uşak University, Faculty of Medicine, Medical Biochemistry Department, Uşak/TURKEY
* Corresponding author; tolgaankaraligil@hotmail.com

Abstract: *In recent years, occupational health and safety have become one of the important elements of working life. The importance of contributing to the protection of employee health by preventing occupational accidents and occupational diseases is increasing demand nowadays. The rapid growth of the catering sector with increasing employment and competition turns into a growing problem: an increase in occupational accidents. In this research carried out with the necessity of taking precautions for the solution to this problem; a risk analysis was conducted in a catering company in Uşak to identify hazards and risks in the company. The hazards and risks are evaluated and precautionary actions were determined according to the current situation. At the same time, it is thought to be beneficial in terms of creating awareness for all companies in the sector by contributing to the protection of employee health by reducing occupational accidents and diseases. Risk analyses were done by the L type matrix (5x5 matrix table). In this study, a total of 131 hazards and risks were identified. The identified hazards and risks are grouped according to their risk level (Unacceptable risk: 5; Significant risk: 61; Medium risk: 59; Acceptable risk: 6). It is considered that adopting proactive approaches within the scope of occupational safety practices will accelerate the spread of the safety network and occupational safety culture to all employees.*

Key Words: *Catering, Risk, Analyze, Occupational, Safety*

Received: August 23, 2019 Accepted: November 29, 2019

1. Introduction

The catering sector in Turkey is the human labor-intensive sector. The number of employees in this sector is increased as the day due to the higher nutritional needs of the public over the years. According to the employment statistics, it is clear that there is a sector that directly and indirectly contacts millions of people [1-2]. The catering sector is listed among the less dangerous sectors according to the list in the legislative regulations in which workplace hazard classes are specified. Nevertheless, employees face many serious risks such as falling, cutting, burning, injury, and death [3-4]. According to the statistics, there has been a significant increase in occupational accidents in the catering sector in recent years. Because of this reason, the precautionary warnings have to be taken in this industry. In the catering industry, a large number of employees can exposure occupational accidents, some of the employees have occupational diseases that can be caused by death [1]. The losses due to occupational accidents that may occur as a result of insufficient or no occupational safety measures are not limited to labor and material losses. The competitiveness and effectivity of enterprises are decreased because of the negatively affected employees. The most important point in the catering industry is to

take precautionary warnings before the occupational accident which can be caused the occupational disease [5].

2. Importance of Risk Analysis in Occupational Health and Safety

The basis of occupational health and safety studies is the risk assessment process. There are the reasons and results of each risk when it occurs. There are internal factors in the workplace that can be caused by risks, besides, the enterprises can be affected by the external factors. Risk analysis focuses on the part where the risk assessment process is integrated into theoretical and mathematical [6]. There are many methods for analyzing risks. Some of these are given in subsection [7].

- Preliminary Hazard Analysis - PHA
- Risk Map
- Job Safety Analysis - JSA
- Preliminary Risk Analysis Using Checklist – PRA
- Preliminary Risk Analysis
- What if..? Analyses
- Degree of Hazard Analyses Method
- Hazard and Operability Studies - HAZOP
- Type of Probable Error and Effect Analyses Method
- Event Tree Analysis - ETA
- Cause and Effect Relationship
- Rapid Ranking Method for the Classification of Unıts
- Safety Audit
- Fault Tree Analysis - FTA
- Risk Assessment Decision Matrix
    - X Type Matrix
    - L Type Matrix

The most important point that separates these risk analysis methods is the differences in the methods they use to find risks. The most commonly used method is the risk assessment decision matrix. The L-type matrix can be used for prompt. The simplicity of the L type matrix is a priority in choosing [8].

One of the most important points in occupational safety is to take precautionary warnings before occupational accidents and diseases occur which is named as a proactive approach. According to the proactive approach, the decrease in occupational accidents and diseases, costs can be distinguished. The enterprises manage their resources better with increasing self-confidence. The risk analyses have to be done for proactive approaches. The risk analysis helps to anticipate potential hazards and risk factors that may occur in enterprises. According to the risk analyses, the impact of the risks can be examined and effective security measures can be planned in detail. The employees play an interactive role to have a safe working condition by the risk analyses. Also, risk analyses help to take quick and accurate decisions by the employer for the elimination of the risks. After the assessment, the importance of the risks in the enterprise is determined and it is decided whether these will be ignored or not, the existing measures in the workplace are checked and the deficiencies are completed. It also provides the

traceability of the results with the help of the documentation during the creation of a safe working environment [8-9].

3. Material and Method

The research was carried out in the catering company with the signing of the permission document by the employer for the risk analysis studies. The time interval of the study was between October 2018 and June 2019. In this study, general information about the catering company, production methods, types of equipment, job groups which are in this sector and the data about occupational accidents and diseases are written. Furthermore, the company was visited at different time intervals for collecting data. The company has 10 employees (7 men and 3 women). The company produces till 1000 meal/person in a day in the company. Some data were collected by visual observation about the company.

In the research, risk analysis was performed by using the 'L type matrix' (5x5 matrix table) [10]. The following steps were followed during the implementation of the risk analysis conducted within this scope [11]. These;

a) Identification of hazards
b) Assessment of hazards
c) Scaling the risks
d) Planning the control measures

stages were applied respectively.

a) For the identification of hazards, the attention has been paid to cover all parts of the company and all work performed by personnel was considered carefully.

b) When assessing the hazards, it has been tried to predict which hazards will affect how much for each of the identified hazards. The damage that may occur after the potential impact was evaluated and also the degree of the hazards was determined.

c) In the scaling of risks, it is tried to predict the harm that hazards will cause in the workplace and the employee. Risks are separated into groups such as low, medium, high risks. High risks mean that it requires immediate action, medium risks do not require urgent action as high risks but medium risks are important for the company and low risks mean that do not require urgent action plans [12]. After this stage, control measures according to risks were tried to be planned. The suitability of the measures was determined for the company and the decrease in the risk level related to the control measures were also taken into consideration [8].

d) While planning the control measures, priority was taken to eliminate the risks. In some cases where this is not possible, priority has been made to reduce the risk level as much as possible [8].

In the study, the probability of an event and the effects of the damage related to the event are tried to be graded together (risk score) using the L-type matrix [13]. To obtain a risk score, the probability of occurrence of an event (Table 1) and the intensity of the damage at the time of occurrence (Table 2) was given a numerical value between 1 and 5, respectively. The risk score is obtained by multiplying the probability and intensity of the event.

$$\text{Risk Score (R)} = \text{Probability} \times \text{Intensity}$$

Table 1. Probability of the Event [8].

Probability Value	**Probability**	**Scaling for the Possibility of an Event**
1	Very Low	The event does not occur anyway.
2	Low	The event occurs rarely.
3	Medium	The event occurs occasionally.
4	High	The event occurs frequently.
5	Very High	The event occurs very often.

Table 2. The intensity of Damage Caused by an Event [8].

Intensity Value	**Intensity**	**Scaling for the Intensity of an Event**
1	Very Low	Events do not result in a loss of working hours.
2	Low	Events do not result in a loss of working days.
3	Medium	Events cause mild injuries.
4	High	Events cause serious injuries
5	Very High	Events cause the death or inability to work permanently.

In the risk score matrix (Table 3), the value of risk was tried to be determined the risk level by multiplying two values as the probability on one side and intensity on the other side of the matrix. In the matrix table, the vertical column indicates the intensity value and the horizontal row indicates the probability value.

Table 3. Matrix of the Risk Score [8].

Matrix of the risk score	**Probability**				
Intensity	1 Very Low	2 Low	3 Medium	4 High	5 Very High
1 Very Low	Senseless 1	Low 2	Low 3	Low 4	Low 5
2 Low	Low 2	Low 4	Low 6	Medium 8	Medium 10
3 Medium	Low 3	Low 6	Medium 9	Medium 12	High 15
4 High	Low 4	Medium 8	Medium 12	High 16	High 20
5 Very High	Low 5	Medium 10	High 15	High 20	Very High 25

The decisions were made to take preventive actions according to the acceptability of the risk level (Table 4).

Table 4. The Acceptability of the Risk Level [8].

Acceptability Value	Preventive Actions
Unacceptable Risk (25)	- The ongoing activities should be stopped immediately. - Activities should not be begun until the risk level is decreased to an acceptable level. - If the risk level does not decrease even if the precaution is taken, the activities should be canceled.
Significant Risk (15-16-20)	- If there are ongoing activities, it should be stopped immediately. - The activities should not be started until the identified risk level is decreased. - If the risk persists with the activity, precautions should be taken quickly.
Medium Level Risk (8-9-10-12)	- The precautions should be taken to decrease the risk level. - The precautions taken to decrease the risk level may take time.
Acceptable Risk (2-3-4-5-6)	- The precautions may not be needed to eliminate risks. - The sustainability of the precautions should be checked.
Insignificant Risk (1)	- It may not be necessary to take precautions for the risks or the records of precautions may not be maintained.

In this study, the hazards and risks were indicated separately, and assessments were made according to the precautions which can be taken, the intensity values, the risk score and the level of acceptability.

4. Results

In this study, a total of 131 hazards and risks were identified. The identified hazards and risks are grouped according to their risk level (Unacceptable risk: 5; Significant risk: 61; Medium risk: 59; Acceptable risk: 6) and shown in Table 5, Table 6, Table 7 and Table 8.

The risk score (multiplication of probability and intensity values) of all unacceptable hazards and risks (risk score: 25) shown in Table 5.

Table 5. Unacceptable Hazards and Risks (R=25)

No	Hazard	Risk	Corrective/Preventive Action
1	Electric panel	Electric shock, injury, death	The panel door must be locked and the key must be for authorized persons only.
2	Insulating matting	Electric shock, injury, death	There should be an insulating mat in front of the electrical panel.
3	Electrical devices, switchboards, transformers	Electric shock, injury, death	All devices in contact with electricity should be kept away from wet areas and appropriate ventilation should be provided in humid areas.
4	Electrical maintenance	Electric shock, injury, death	During maintenance, breakers must be closed and labeling-locking procedures should be applied.
5	Leakage relay	Electric shock, injury, death	Electrical panels must be fitted with a leakage relay in accordance with the regulations.

The risk score which calculated by multiplication of probability and intensity values of the significant hazards and risks were found between 15 and 20 and was shown in Table 6. Those whose risk score is calculated as 20 are shown as numbers 1-24, those calculated as 16 are shown as numbers 25-56, and those calculated as 15 are shown as numbers 57-61.

Table 6. Significant Risks and Hazards ($15 \leq R \leq 20$)

No	Hazard	Risk	Corrective/Preventive Action
1	No emergency practices	Employees do not know what to do in case of emergency	Regular emergency practices should be done.
2	Lack of emergency warning and communication system	Late emergency interference, loss of property and death	An audible warning system must be established. The personnel in charge should be informed.
3	Lack of first aid cabinet	Employees can not do anything in case of emergency	The first-aid cabinet should be placed within easy reach.
4	Missing material in the first aid cabinet	Late intervention in emergencies	All necessary first aid materials should be available in the cabinet.
5	Lack of first aid training to the employees	Late intervention in first aid	Employees should be provided with first aid training.
6	An obstacle in front of fire extinguisher	Late fire interference	Obstacles in front of the fire extinguisher must be eliminated and personnel must be informed about this subject.
7	Lack of fire warning system	Late fire interference, injury, death	A fire warning system, emergency button, light, and audible warning system should be established.
8	Untrained employee	Late fire interference, injury, death	Fire training should be provided.
9	Wear of electrical cable insulation	Electric shock, injury, death	Wear electrical cables must not be used.
10	Do not leave unplugged hand tools plugged in	Electric shock, injury, death	Unused hand tools should not be left plugged in, employees should be informed about this issue.
11	The electrical cables are not in the protective cable duct	Electric shock, injury, death	All electrical cables must be located inside the protective duct.
12	Lack of lightning rod	Lightning strike, fire, injury, death	It must be ensured that the lightning rod is inspected by authorized persons every year in accordance with the fire regulations.

No	Hazard	Risk	Corrective/Preventive Action
13	Not wearing personal protective equipment	Electric shock, injury, death	Electrically operated personnel should be provided with personal protective equipment such as insulated gloves and insulating shoes.
14	Untrained and unauthorized persons in charge of electrical works	Electric shock, injury, death	It should be ensured that the electrical works are carried out by trained and authorized personnel.
15	Lack of electrical warning signs	Electric shock, injury, death	Electrical hazard areas must be marked with warning signs and unauthorized persons must be prevented from entering these areas.
16	Lack of static grounding measurement of machines	Electric shock, injury, death	Static grounding measurements of all types of equipment and machines in the company should be ensured to be carried out within the specified periods in accordance with the regulations.
17	Lack of emergency stop buttons of machines	Injury, loss of limb	Emergency stop buttons are required for all machines.
18	Emergency stop buttons of the machines not working or canceled	Injury, loss of limb	The emergency stop buttons of the machines must be in working order and must never be canceled.
19	Lack of machine protections	Injury, loss of limb	The machines without protections must never be operated.
20	Disassembling and canceling machine protection	Injury, loss of limb	The machine protectors must never be removed or canceled.
21	Electrical cables of the machine are placing in the ground	Electric shock, injury	All cables passing through the ground must be passed through insulating lines.
22	Employees who use cutting equipment do not wear protective gloves	Cut, rupture, injury	Employees should wear protective gloves that are suitable for their job.
23	Uneducated employees using cutting equipment	Unconscious use, accidents	Employees should be trained about the risks of the tools.
24	Unstable cutting equipment	Accidents	All cutting equipment in operation must be checked regularly.
25	Placing the electrical cables untidy.	Stuck, fall, injury	The untidy electrical cables should be collected in the cabinet.

No	Hazard	Risk	Corrective/Preventive Action
26	No warning signs for machinery and equipment	Accidents	Appropriate warning signs should be provided.
27	No labeling-locking procedure is applied during machine cleaning and maintenance	Accidents, injury	The labeling-locking procedure should be applied for machine cleaning and maintenance operations.
28	Use of machines by untrained persons	Accidents, injury	Machines should only be used by trained and authorized personnel.
29	Non-Turkish buttons on the machine	Unconscious use, accident	Non-Turkish buttons on the machines should be labeled in Turkish.
30	Hot Surfaces	Burning from hot surfaces	It should be ensured that employees use heat-resistant gloves when working on hot surfaces.
31	Lack of sharpening of cutting tools	Accidents	Cutting tools must be sharpened regularly.
32	Use of cutting tools on non-smooth cutting surfaces	Accidents	Cutting tools must be used on smooth cutting tables.
33	Lack of instruction manual of the equipment	Unconscious use, accident	The instruction manual of the equipment should be prepared and employees should be informed about the instruction manual.
34	Failure to remove cutting equipment after use	Accidents	All cutting equipment should be removed after use.
35	Material stacking at high points	Material drop, injury	Materials do not stack at high points.
36	Paying no attention to height and balance during the stacking of the equipment	Material drop, injury	The height and balance of the equipment should be taken into consideration when stacking.
37	Uncontrolled opening of the lid when cooking in boilers	Accidents	The boiler lid should be opened properly and the employee should not be exposed to superheated steam.
38	Do not use opening apparatus when opening packages such as canned foods.	Accidents	Employees must be used as the opening apparatus for canned foods. Cutting equipment such as nice should not be used for the opening of the packages.

No	Hazard	Risk	Corrective/Preventive Action
39	Maintenance of the range hood.	Fire	The cleaning and maintenance of the range hood must be regularly and records must be kept.
40	Inability to open the door from the inside	Locked in	The doors can be opened from the inside in case they remain locked.
41	Locked in the refrigerator	Freezing	Employees should not enter the refrigerator alone and must be accompanied by one person at the door.
42	No warning system inside of the refrigerator	Freezing	An audible warning system should be installed in the refrigerator and it should be operational.
43	Not wearing appropriate clothing in the refrigerator	Cold exposure, freezing	Appropriate thermal clothing should be provided for personnel entering the refrigerator and personnel should not be allowed to work without thermal clothing for a long time.
44	Slippery ground	Slip, fall, injury	If liquid spills in the refrigerator, the liquid must be cleaned immediately to prevent freezing and falling.
45	Personal protective equipment	Material drop, slip, fall, injury	Employees must wear non-slip shoes for preventing slipping and falling.
46	High stacking	Accidents	There were not made high stacking in the refrigerator.
47	Material drop, overturn	Injury	The shelves inside the refrigerator must be secured against overturned.
48	High stacking	Accidents	There were not made high stacking in the storage.
49	Lack of health report of employees	Lack of knowledge about employees for a suitable job.	Employees must be provided with health reports indicating their suitability before starting the job.
50	Periodic repetition of clinical examination	Failure to follow the health status	The clinical examination should be periodically renewed in accordance with the regulation periods to observe the health status of the employees.
51	Inadequate cleaning of the working environment	Infectious disease	The work environment should be cleaned regularly with suitable cleaners.
52	Biological risks and lack of hygiene education	Unconscious work, infectious disease	Employees should be provided with hygiene training about biological risks.

No	Hazard	Risk	Corrective/Preventive Action
53	Continuing to work with an open wound.	Acquiring an infection, infectious disease	Employees with an open wound must be prevented from working.
54	Pest control and disinfection	infectious disease	Pest control and disinfection should be done regularly.
55	Unhygienic sinks	infectious disease	Sinks should be cleaned regularly and disinfectants should be applied at regular intervals.
56	Slippery ground	Slip, fall, injury	The wetness of the sink surface must be removed after cleaning.
57	Lack of emergency teams	Chaos during emergencies	Employees should be informed about emergency teams and plans.
58	Lack of emergency telephone numbers	Inaccessibility of emergency numbers	Emergency numbers should be posted in an appropriate place in the company and information should be provided to the employees.
59	Difficulties to reach a fire extinguisher	Late fire interference	Fire extinguishers should be placed in easily accessible places.
60	Lack of firefighting training	Lack of fire intervention	Fire training should be given and practices should be done regularly.
61	Unconsciously burning fire	Fire, Injury	The unconscious fire should be prevented and personnel should be informed about it.

The risk score which calculated by multiplication of probability and intensity values of the significant hazards and risks were found between 8 and 12 and was shown in Table 7. Those whose risk score is calculated as 12 are shown as numbers 1-47, those calculated as 9 are shown as numbers 48-52, and those calculated as 8 are shown as numbers 53-59.

Table 7. Medium Level Risk ($8 \leq R \leq 12$)

No	Hazard	Risk	Corrective/Preventive Action
1	Lack of emergency exit	Inability to go out in case of emergency	The information must be given to the employees.
2	No warning sign on the emergency exit	Difficult to find the emergency exit	Signs on the emergency exit must be seen in all situations.
3	The obstacle in front of emergency exit	Inability to go out in case of emergency	There should not be placed any material in front of the emergency exit and information should be provided to the employee.
4	Lack of assembly area	Not being in an assembly area in	The information should be provided to the employee about the assembly area.

No	Hazard	Risk	Corrective/Preventive Action
		case of emergency	
5	No fire extinguisher	Late fire interference	Fire extinguishers should be checked regularly.
6	Unsuitable type of fire extinguisher	Inability to interfere to fire	Fire extinguishers should be selected according to the operation.
7	Lack of periodically maintain the fire extinguisher	Late fire interference, injury, death	The control and filling of the devices must be carried out in accordance with the regulations by the authorized person and within periods.
8	Leaving electrical equipment and devices on the mode	Fire, Injury	The electrical devices should not be left open and the information must be given to the employees.
9	Slippery ground	Slip, fall, injury	Slippery areas in the plant should be identified and indicated with warning signs.
10	Wet floor/residuum	Slip, fall, injury	The warnings should be placed on wet floors and the floor should be cleaned in a short time.
11	Irregular work area	Hanging, falling	The materials used in the company should not be left irregularly, the materials should be replaced after usage.
12	Environmental cleaning	Epidemic Illnesses	The plant must be cleaned regularly. Waste areas should be created.
13	General warning signs	Unconscious movement, inability to foresee danger	The warning signs must be placed at the company.
14	On-the-job training	inability to foresee danger	On-the-job training should be given to the new employee.
15	Pouring slippery substance to the floor	Slip, fall, injury	Slippery materials should be cleaned immediately.
16	Lack of personnel protective equipment usage	Slip, fall, injury	Employees should be provided with non-slip shoes or boots.
17	Slippery ground	Slip, fall, injury	Precautions should be taken to prevent slipping on the floor.
18	Drainage	Slip, fall	The drainage must be made of non-slip material.
19	Lack of vehicle reverse signaling system	Crash, injury, death	All vehicles must have a reverse gear audible warning system.
20	Non-compliance with traffic rules	Crash, injury, death	Training should be provided to employees about the traffic rules.

No	Hazard	Risk	Corrective/Preventive Action
21	Lack of personnel protective equipment usage	Accidents	The information must be given to the employees and the employees should wear personal protective equipment appropriate to the work.
22	Wearing oversized clothes	Accidents	The employees should not wear oversized clothes.
23	Jewelry	Accidents	The employees should not wear jewelry during the operation.
24	Levity	Accidents	The employees should not joke with one another during the operation.
25	Thermal comfort	Discomfort, depression	The maintenance of the ventilation system must be regularly.
26	Unsuitable railings	Accidents	The suitable railings should be used in the company.
27	Lack of clean and tidy access roads and corridors	Stuck, fall, injury	Roads and corridors in operation must always be clean.
28	Cleaning precautions	Slip, fall, injury	Necessary precautions should be taken during cleaning and after cleaning in the cleaned areas and the floor should not be left wet.
29	Unusual increase in temperature	Pathogen microorganism growth, disease formation	In order to prevent food spoilage and to prevent the spread of pathogenic microorganisms, refrigerator temperature controls should be checked regularly and the cooling system should be periodically maintained and calibrated.
30	The material drop	Injury	Shelves in the refrigerator must be secured.
31	Untidy and uncleaned areas	Accidents	The refrigerator should be clean and tidy.
32	Untidy and uncleaned areas	Accidents	The storage should be clean and tidy.
33	Lack of personnel protective equipment	Accidents	Appropriate personal protective equipment should be used in chemical use.
34	Lack of material safety data sheet	Lack of knowledge in case of emergencies	The chemicals must have material safety data sheets.
35	Unsuitable chemical package	Lack of knowledge about chemical	Chemicals must be kept in their original packaging.
36	Suitable storage after usage	Accidents	Chemicals must be removed to the storage room after usage.
37	Wet floor	Slip, fall, injury	The floor should not be left wet after cleaning.

No	Hazard	Risk	Corrective/Preventive Action
38	Lack of personnel protective equipment	Poisoning, tissue damage, allergy	Personal protective equipment such as gloves, mouthpiece, apron, non-slip boots should be used when cleaning.
39	Lack of material safety data sheet (MSDS)	Unconscious use, poisoning	Safety data sheets (MSDS) of chemical materials must be available.
40	Unsuitable chairs, benches, etc. used by employees.	Musculoskeletal disorders	Equipment used by employees such as chair bench should be adjustable according to physical measurements.
41	Lifting of heavy things by hand	Musculoskeletal disorders	Transport equipment must be available for heavy things.
42	Inadequate number of the cabinet for clean and dirty clothes	Infectious disease, theft of personal belongings	Adequate and lockable cabinets are required to put clean and dirty clothing separately.
43	Putting something on the cabinet	Material drop, injury	The materials should not put on the cabinet.
44	Inadequate lightening	Accidents	The lighting apparatus should be arranged according to the existing areas.
45	Inadequate ventilation	Infectious disease	Adequate ventilation should be provided in locker rooms.
46	Inadequate hygiene in the locker rooms	Infectious disease	The cleaning must be done in the locker room regularly.
47	Inadequate hygiene in bathrooms	Infectious disease	The cleaning must be done in the bathrooms regularly.
48	Lack of personnel protective equipment	Accidents, injury	The appropriate personal protective equipment should be used according to the operation.
49	Puddles on the ground	Slip, fall	An adequate number of drainage systems must be provided for puddles.
50	Drainage	Hanging, falling	The level of drainage and ground must be the same.
51	Grid range of drainage	Hanging, falling	The grid range of the drainage must be prevented the hanging.
52	Untidy materials	Hanging, falling	Workplace irregularity should be avoided.
53	Driving license	Crash, injury, death	Vehicles in operation must only be operated by authorized employees.
54	Failure of the vehicle	Crash, injury, death	The maintenance and control of the vehicles should be made regularly and records must be kept.
55	Fire in the vehicle	Fire	The vehicle must have a fire extinguisher.
56	Improper stacking of vehicles	Injury, accidents	The materials should be load in proper design to the vehicle.

No	Hazard	Risk	Corrective/Preventive Action
57	Lack of control after loading of the vehicle	Material drop, accident, injury	Before the vehicles move, the tailgate, etc. should be checked.
58	Employees traveling in the vehicle trunk	Injury, accidents	Employees must not travel in the vehicle trunk.
59	Inadequate number of sitting chair	Falling in the locker room	An adequate number of sitting chairs must be provided for employees in the locker room.

The risk score which calculated by multiplication of probability and intensity values of the significant hazards and risks were found between 2 and 6 and was shown in Table 8. Those whose risk score is calculated as 6 are shown as numbers 1-4, those calculated as 5 are shown as number 5, and those calculated as 4 are shown as numbers 6.

Table 8. Acceptable Risks ($2 \leq R \leq 6$)

No	Hazard	Risk	Corrective/Preventive Action
1	Material stack	Hanging, falling	Materials should not be left in the middle of the floor. Precautions should be taken to prevent hanging and falling.
2	Inadequate lightening	Crash, hanging, falling	The lighting apparatus should be determined according to the areas.
3	Floor fracture, collapse	Hanging, falling	In case of damage such as collapse or floor fracture, these places should be corrected.
4	Broken bounds in the drainage grids	Hanging, falling, injury	The drainage grids should be checked and replaced in case of fracture.
5	locking the emergency exit door	Inability to go out in case of emergency	The emergency exit door must never be locked.
6	Drinking while driving	Crash, injury, death	The training must be given to employees about drinking while driving.

5. Discussion and Conclusion

According to the data obtained from the study, all of the unacceptable risks are related to electrical works. The operations should be stopped immediately and should not be started without taking precautions to reduce the risk level. The high-level risks give very serious damage to the employees such as an inability to work continuously and death. Significant risks are caused by emergencies, fire, electricity, stoves-ovens, and other machinery, cutting-piercing tools, hazardous behavior and situations, working environment, refrigerator, storage, biological factors, cleaning, locker rooms, and bathrooms. It is observed that middle-level risks are caused by emergencies, fire, general operation, floor, vehicle use, hazardous behavior and situations, working environment, storage, refrigeration, chemicals, cleaning, ergonomics, locker rooms, and bathrooms. Acceptable risks are caused by emergencies, general operation, ground and vehicle use.

According to the data in our study, some of the hazards occur due to the nature of the work performed and some of them are caused by the equipment used in the company. It is determined that intense work tempo, lack of training and lack of personal protective equipment increase the risk level.

In other studies, it was determined that cutting materials, slippery floor, cleaning, slip-falling, dangerous behavior, biological materials, storage areas, hot-cold areas, workload, time pressure, stress, lack of education cause risks and accidents [14-15]. Providing occupational safety training and using personal protective equipment will help to reduce the risk level of most hazards. Similar results were obtained at the other study about the opinion about wearing personnel protective equipment [15-16].

It is considered that adopting proactive approaches within the scope of occupational safety practices will accelerate the spread of the safety network and occupational safety culture to all personnel. Otherwise, human-oriented preventive approaches are effective in controlling risks [17]. As a result of this study, the most appropriate approach for the company to start occupational health and safety studies at the installation stage. In this way, it will be possible to reduce occupational accidents and prevent the accident costs and also it helps competition and productivity gains of the company.

References

[1] T.C. Sosyal Güvenlik Kurumu, SGK İstatistik Yılları, 2018. Erişim Tarihi: 04.11.2018.http://www.sgk.gov.tr/wps/portal/sgk/tr/kurumsal/istatistik/sgk_istatistik_yilliklari

[2] TRT Haber, Hazır Yemek Sektöründen 66,5 Milyar Lira Ciro, 2018. Erişim Tarihi: 04.11.2018.https://www.trthaber.com/haber/ekonomi/hazir-yemek-sektorunden-665-milyar-lira-ciro-321286.html

[3] İş Sağlığı Ve Güvenliğine İlişkin İşyeri Tehlike Sınıfları Tebliğinde Değişiklik Yapılmasına Dair Tebliğ, EK-1 İşyeri Tehlike Sınıfları Listesi (29.03.2013) Resmi Gazete, 28602.

[4] Ünver, M., Toplu Yemek Hizmeti Sektöründe İş Sağlığı ve Güvenliği. İş Sağlığı ve Güvenliği Uzmanlık Tezi, *Çalışma ve Sosyal Güvenlik Bakanlığı İş Sağlığı ve Güvenliği Genel Müdürlüğü*, Ankara, 3, 5, 9-12, 2016.

[5] Sormaz, Ü., Demirçivi, B., M., et al., Dışarıya Yemek Hizmeti Veren (Catering) İşletmelerde Çalışanların İş Güvenliği Bilgilerinin Değerlendirilmesi. *Aksaray Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 6 (2), 62-63, 2014.

[6] İş Sağlığı ve Güvenliği Kanunu (2012), T.C. Resmi Gazete, 28339, 20.06.2012.

[7] Güçlü, M. , OHSAS 18001 İş Sağlığı ve Güvenliği Yönetim Sistemi, Yüksek Lisans Tezi, *Sakarya Üniversitesi Sosyal Bilimler Enstitüsü*, Sakarya, 31-33, 2007.

[8] Özkılıç, Ö., İş Sağlığı ve Güvenliği Yönetim Sistemleri ve Risk Değerlendirme Metodolojileri, Türkiye İşveren Sendikaları, Ankara, 47, 55-60,113-115, 2005.

[9] Bıyıkçı, E., T., İş Sağlığı ve Güvenliğinin Sağlanmasında İş Güvenliği Uzmanlığı. Yüksek Lisans Tezi, *Uludağ Üniversitesi Sosyal Bilimler Enstitüsü*, Bursa, 1, 2010.

[10] Önder S., Suner N., et al., Madencilik Sektöründe Meydana Gelen İş Kazalarının Risk Değerlendirme Karar Matrisi İle İncelenmesi. *Türkiye 22. Uluslararası Madencilik Kongresi ve Sergisi*, 11-13 Mayıs, 2011, Ankara, 403, 2011.

[11] Ağca, E., Mermer Fabrikalarında İş Güvenliği Risk Analizi. Yüksek Lisans Tezi, *Çukurova Üniversitesi Fen Bilimler Enstitüsü*, Adana, 29-34, 2010.

[12] Güçlü, M., OHSAS 18001 İş Sağlığı ve Güvenliği Yönetim Sistemi. Yüksek Lisans Tezi, *Sakarya Üniversitesi Sosyal Bilimler Enstitüsü*, Sakarya, 31-33, 2007.

[13] TMMOB Elektrik Mühendisleri Odası, İşçi Sağlığı ve Güvenliğinde Risk Analizleri Nasıl Yapılır? *EMO/445*, Ankara, 30-34, 2012.

[14] Dienstbuhl, I., Michaelis, R., et al., Protecting Workers in Hotels, Restaurants and Catering. https://osha.europa.eu/en/publications/reports/TE7007132ENC_horeca Erişim Tarihi: 12.05.2019.

[15] European Agency for Safety and Health at Work, 2008. Protecting Workers in Hotels, Restaurants and Catering. https://osha.europa.eu/en/publications/factsheets/79 Erişim Tarihi: 09.06.2019.

[16] Health and Safety Executive, 2013. Managing Risk In Catering and Hospitality: Your Responsibilities. http://www.hse.gov.uk/pubns/cais25.pdf Erişim Tarihi: 12.06.2019.

[17] Arocena, P., Nùñez, I., et al., "The Impact of Prevention Measures and Organisational Factors on Occupational Injuries", *Safety Science*, 46(9), 1369-1384, 2008.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.05

IJHSRP

Research Article

THE VALUE OF DIFFERENT TUBERCULOSIS (TB) CASE DETECTION STRATEGIES IN CHILDHOOD TB CONTROL IN A HIGH-TB BURDEN POPULATION DENSE AREA, WESTERN KENYA, 2012-2015: A CLUSTER RANDOMIZED TRIAL

***Barbara K. Burmen[1], Timothy M. Malika[2]**

[1]Kenya Medical Research Institute, Center for Global Health Research, P.o. Box 1578-40100, Kisumu, Kenya
[2]Division of Leprosy, Tuberculosis and Lung Disease, P.O. Box 20781 – 00202 Nairobi, Kenya
*Corresponding author: drburmen@gmail.com

Abstract: *Contact investigation is recommended for close contacts of tuberculosis (TB) patients to identify undiagnosed cases of active and latent TB to initiate them on curative and preventive therapy respectively. However, contact invitation is conducted in Kenya and therefore the value of TB contact investigation in childhood TB control is unknown. To compare the yield of contact investigation (intervention arm) to contact invitation (control arm) in contributing to childhood TB control, a cluster-randomized trial was conducted in Kisumu County between 2014 and 2015 a period prior to the implementation of standardized contact investigation. This was done to compare TB cases diagnosed and children receiving Isoniazid Preventive Therapy (IPT) in the pre-intervention (2012-2013) and intervention (2014-2015) years, and during in the intervening years using a minimum sample size of 15 per arm. Of 77 facilities identified for the study, 65 facilities were randomized to a contact screening strategy; a TB contact investigation strategy in isolation (n=4), in combination with health facility screening (n=19), or in combination with both enhanced facility screening and mobile units (n=31) with the remainder, (n=11) randomized to the standard approach i.e. TB contact invitation. Facilities distribution did not differ by category of services or patient type. In the pre-intervention and post-intervention years, the number of TB cases diagnosed in children increased by 20 (75% from intervention arm). During the intervening years, TB cases decreased by 17 (29% from intervention arm); the intervention arm contributed to 100% and 75% of the children put on IPT whose implementation had just begun. Contact investigation enhanced childhood TB control in comparison to routine approaches. Critical support ought to be availed to the TB screening cascade to facilitate contact investigation and IPT implementation as well as ingrain contact investigation within existing community health systems.*

Keywords: *Tuberculosis case detection strategies, contact investigation strategies, enhanced facility-based screening, mobile units, childhood TB, high-TB burden, cluster-randomized trial, Kenya,*

Received: May 21, 2019 Accepted: September 9, 2019

1. Introduction

Value in health care has been defined as health outcomes per dollar spent [1]. A valuable health care program is one that improves health care outcomes at a reasonable cost or achieves the most improvement with the available resources. This is because not all programs have a positive return on investment e.g. prevention programs across broad populations usually have low yield but result in a decrease in morbidity and mortality [2]. The value should always be defined around results i.e. the health outcomes achieved which are usually are disease-specific and multidimensional [1].

'Disease control' is defined as a decrease in the incidence, prevalence, morbidity, and mortality from the disease [3]. To reduce Tuberculosis (TB) incidence and prevalence by 2005, in 1991, the World Health Assembly set two TB control targets of a TB Case Detection Rate (CDR) of 70% and a TB treatment success rate of 85% [4]. In 2014, the World Health Assembly set a new strategy to end TB (defined as a TB incidence to < 10 per 100,000 populations) by 2035. A milestone in this strategy (the Global Plan Targets 2015 to 2025) was to reach 90% of all undiagnosed TB cases, 90% of all key populations, and attain at least 90% TB treatment success. Key populations, who are the most vulnerable and underserved 'at risk' populations include children, People Living with HIV (PLHIV), indigenous peoples, healthcare workers, mobile population, People who Inject Drugs (PWID), rural populations, urban populations, miners, prisoners, etc. Each government would define its key populations, plan and implement appropriate services to suit them, and measure progress towards these targets [5]. Due to its potential benefits, TB active case finding is recommended in regions with high TB prevalence, low detection rates and moderate to high treatment completion rates[6].

Contact investigation aims to identify and treat new cases of TB, administer preventative therapy to contacts in whom TB is ruled out, or to closely monitor household transmission [7]. The likelihood of developing TB infection following a positive tuberculin skin test higher in younger persons [7]. Screening contacts of known TB cases is only useful if TB prevention Isoniazid Preventive Therapy (IPT) is given to persons with to prevent disease progression or TB treatment is effected [8]. Household contacts are the focus of TB contact investigation as they are at an increased risk of TB infection due to prolonged exposure with a TB index case [9]. Among household contacts, the risk of TB infection following exposure is highest among children [10]. In India, the yield of TB contact investigation among young children living in households of smear-positive TB cases ranged from 22-34% and was higher (27-62%) among children aged less than 10 years. The majority of TB infections among children aged <3 years occurred from household contact. Conducting household contact investigation in this age group, therefore, led to earlier diagnosis and treatment, prevent the occurrence of complications, and reduce the pool of future latent Tuberculosis infection (LTBI) cases [11]. In a study in Peru, the prevalence of TB detected in household contacts through active case finding was higher than through passive case finding (0.91% vs. 0.18%). Similar results were observed among neighbors of the index case i.e. 0.22% vs. 0.08% respectively [12].

Ayles et al (2013) assessed the effect of two community-level interventions on TB control among adults aged 18 years and older. These interventions were implemented as follows; within the clinic alone (Group 1), within the clinic plus enhanced community level case-finding ECF (Group 2), enhanced community level case-finding plus household contact investigation (Group 3), and clinic plus enhanced community level case-finding plus household contact investigation (Group 4). The prevalence of TB was 832 per 100,000 populations. The adjusted prevalence ratio for ECF (Groups 2, 3 & 4) vs. non-ECF (Group 1) was 1.09 and for household vs. non-household was 0.08. The adjusted incidence ratio for a group of children followed up for 3 years for ECF vs. non-ECF was 1.36 and for household vs. non-household was 0.45. As these interventions were designed to decrease TB transmission and ultimately TB prevalence, a longer follow-up period may have been required to assess their effect. Additionally, screening limited to only sputum smear-positive cases [13]. In India, among child contacts aged less than 5 years, 30% of TB cases would have been missed by focusing only on sputum positive index cases. This is because the majority of sputum negative cases do not have the minimum 10,000 (Acid-fast bacilli) AFB per ml required for a positive Zeihl-Neelsen stain [14].

In 2012, the World Health Organization (WHO) provided recommendations for investigating contacts of persons with infectious TB in low- and middle-income countries. However, these did not specify guidelines for specific programmatic conditions under which contact investigation should be conducted, the types of index cases to be prioritized for screening, specific protocols to be followed, or the contacts to be investigated (other than children aged < 5 years and PLHIV) [15].

The TB program in Kenya was formally launched in 1980. The TB Case Notification Rate (CNR) in 1980 was 60 per 100,000 populations. Before the advent of HIV in Kenya, the TB CNR was falling at a rate of 4% per year. With the onset of the HIV epidemic in the 1990s, the TB CNR has begun increasing at 15% per year with a peak CNR of 300 cases per 100,000 population in 2005 [16]. In Kenya, between 1987 and 2006, the TB burden increased ten-fold due to Human immune-deficiency Virus (HIV) infection [17]. In 2016, the TB CNR in Kenya was 170 per 100,000 populations and in Kisumu County, 228 per 100,000 populations. Over 90% (75,986) of the TB case burden in Kenya was borne by adults. Kisumu County, one of the 47 counties in Kenya, contributed to 2,564 (3.4%) of the 75,896 TB cases notified in 2016 [18]. In 2012, Kisumu County had the highest HIV prevalence in the country, 15.1% against the country's average of 5.6% [19]. By 2005, Kenya had already reached the targets for TB Case Detection Rate (CDR) of 70% and cure rates of 85% [16]. From 2010, the TB program in Kenya increased expanded its focus on active case finding to screening HIV infected persons, new inmates in prisons, household or community cough monitors and household contacts of index cases of TB [20].

The Kenya TB program guidelines recommend IPT for TB prevention for all children aged < 5 years who have been in household contact with a TB index case in whom a TB diagnosis has been excluded, as part of its underserved populations [21]. Although household contact investigation is included in Kenya TB Control policies, it has not been conducted in Kenya as it is the resource-intensive case [22]. TB screening among household contacts in Kenya is non-standardized and limited in scope to contact the invitation. Subsequently, the information on the contribution of contact investigation to early case detection in children is scarce or non-standardized. This precludes the assessment of its impact on TB control (WHO, 2012). The absence of information on the uptake of IPT uptake following among child contacts household with exposure further hampers such assessments [23]. In view of this discrepancy, there is a need to assess the contribution of contact investigation to diagnosing and preventing TB in children. The objective of this study was to compare the value of TB contact investigation to TB contact invitation in childhood TB control.

2. Methods

2.1. Study design

The TB contact investigation study was nested within a larger TB case detection study, a cluster-randomized trial conducted within 18 distinct geographical regions (clusters) in Kisumu County to determine the increase in TB case detection (for both drug-resistant and drug-susceptible TB) achieved through 3 different TB case detection strategies. In this study, a cluster was defined as a contiguous geographic unit with a population of approximately 25,000 persons based on the Kenyan 2009 census [24]. The TB case detection study's sites were selected based on being in a country with a national TB incidence rate > 50/100,000 population, an in-country CDC office affiliated with existing TB activities which could easily be expanded to include contact investigation, a strong track record for successful collaboration with CDC, and either high HIV prevalence or high MDR-TB rates or both.

Cluster randomized trials provide evidence for the effectiveness of TB case detection in comparison

to passive case finding [25] and should be used to provide evidence to support decision making [13]. A sub-group analyses of individuals randomized to the contact investigation strategy was compared to those that offered a standard of care. The CONSORT guidelines for reporting clinical trials with extensions for cluster trials were used to guide the preparation of this section [26].

2.2. Study setting

The study was conducted at 4 of the 7 subdivisions (which now approximate the new sub-counties) of Kisumu county [27]. (3 urban and 1 rural) and within 85 of its 204 health facilities that include 146 level II, 46 levels III, 21 level IV and 1 level V health facilities. There are 6 levels of health care facilities in Kenya; community, dispensaries, health centers, district hospitals, provincial hospitals, and national referral hospitals referred to as levels 1, 2, 3, 4, 5, and 6 respectively [28]. The rural region was Kombewa and urban regions were Kisumu East, West, and Central. The regions were selected based on having 6 contiguous locations that contained approximately 25,000 persons based on the 2009 Census. The urban regions contained 12 units while the rural unit contained 6 units [29, 30]. Kisumu County located in Western Kenya, is a high TB burden, densely-populated region; it has a population of 1,097,307 of whom 17.4% are aged less than 5 years. Its population density of 464.5 per square kilometer [29]. In 2016, the TB CDR was 228 against a national average of 170 per 100,000 populations [18]. Figure 4 shows health facility distribution in Kisumu sub-counties with different counties represented using different colors.

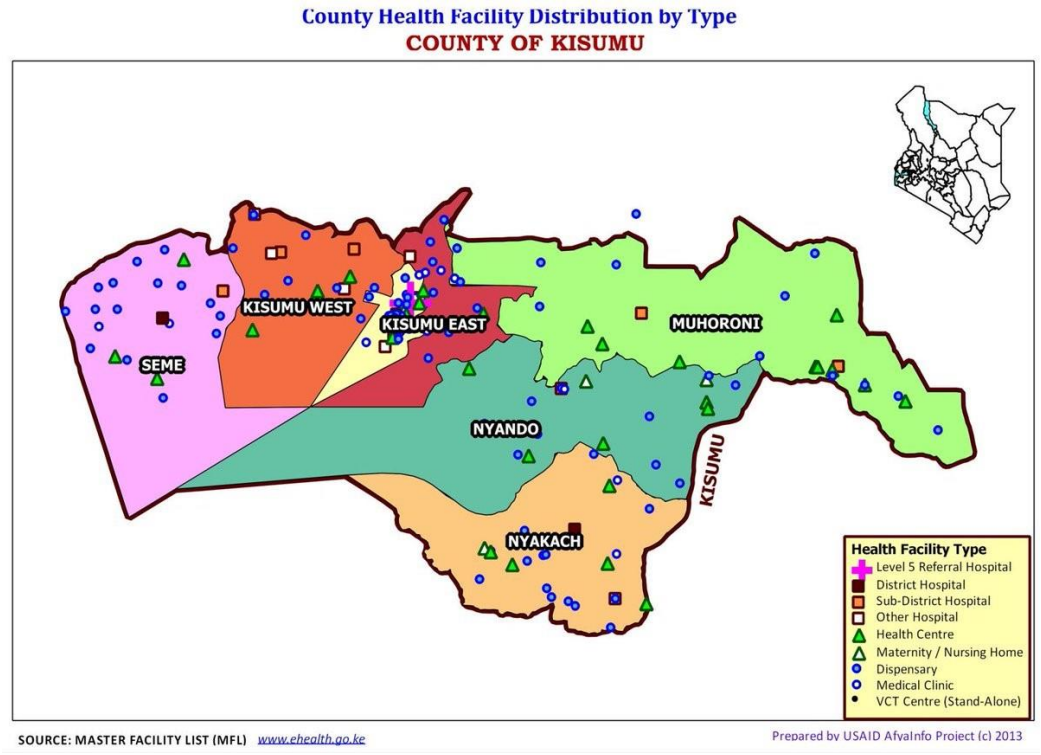


Figure 1: Kisumu sub-counties showing facility distribution (Source: Ministry of Health, 2017)

2.3. Study population

Health facilities within a location were assigned to the cluster to which the location found. The study population was comprised of all children diagnosed with TB or who received IPT within the

specified health facilities randomized to a specific strategy.

To address this objective, the study population was comprised of all children aged less than 5 years who were diagnosed with TB and who received IPT at health facilities randomized to the TB contact investigation strategy and the standard approach (a.k.a. the contact invitation strategy) in the two years preceding the study period i.e. 2012 and 2013 (the pre-intervention period) and in during the two years that were designated the 'study period' (or intervention period i.e. 2014-2015).

The study population was chosen as it represents what would constitute TB control i.e. the number of TB cases diagnosed as a proxy for a decrease in morbidity and mortality from TB, and the number of children who received IPT as a proxy for the number of TB cases of TB prevented and therefore a decrease in TB incidence and prevalence [3]. The health facilities randomized to a specific control strategy would provide both a suitable intervention arm (e.g. the contact investigation strategy) and a suitable control arm the standard approach) because of randomization balances both the known and unknown confounding factors that would influence the outcome [31].

All persons residing within the region randomized to a TB case detection strategy or presenting to a health facility within the region were eligible for inclusion in the strategy to which that unit was randomized. This is because patients can present to a variety of health facilities for TB diagnoses within a larger area. As large areas were randomized to either receive or not receive an intervention, the impact of patients who went outside this area for TB diagnoses and treatment would be limited [13]. Before and after comparisons enabled the study to assess the presence of external changes that may have occurred in both the intervention and control arms during that may have contributed to changes in the outcome e.g. the introduction of new policies or practices in the TB program [32].

2.4. Sample size and sampling procedure

The sample population consisted of at least 19 children aged less than 5 years diagnosed with TB and 15 children aged less than 5 years who received IPT within the intervention and control arms. The study population of child contacts diagnosed with TB was computed as follows: To detect a 50% increase in the number of TB cases between pre and post-intervention period, with one-sided 5% significance and a power of 80% power if any single intervention were anticipated to achieve its target [33].

$n= (p_1(1-p_1) + p_2(1-p_2)) /(p_1-p_2)^2 *. f(\acute{\alpha},\beta))$

Where p_1 is the proportion after the intervention and p_2 is the proportion before the intervention and f ($\acute{\alpha},\beta$) is a constant value for the power and significance level which at 80% power and 95%significance level is 7.9 [33].

TB Patient diagnostic rate =TB case detection rate/TB prevalence was used as the proportion before the intervention [34]. In 2012, the TB case detection rate was 242 per 100,0000 [17], TB prevalence from the TB prevalence survey in 2015 was 586 per 100,000 [35]. Patient diagnostic rate (p1) was therefore 0.41 and p2 0.82.

$n = ((0.82(1-0.0.82)) + (0.41 (1-0.41))/ (0.82-0.41)^2 * 7.9$

$n = (0.82* 0.18 +0.41*0.59) /0.41^2 *7.9$

n =18.3 n=19

A minimum sample size of 18 TB cases in each group (the pre and post intervention groups) would therefore be required to be 80% sure of being able to detect an increase in screening rates at the 5% significance level. The number of child contacts who received IPT was based on the WHO and Kenyan TB treatment recommendation of at least one child contact aged less than 5 years initiated on IPT for

every index case of TB (1:1) [15].

The study employed a convenience sampling technique that collects information based on the availability and willingness of participants. This method is useful as participants were recruited from participating clinics prospectively and there were constraints on time and costs of conducting the study [36]. This method was also chosen due to a small target population as childhood TB represents less than 10% of all TB cases diagnosed [37], and as IPT implementation had just commenced, there was no existing information on which to base sample estimates (Tuberculosis, Leprosy, and Lung Diseases Coordinator, Nyanza Province, Personal Communication, 30th August 2012).

2.5. Randomization

Four regions (two urban and two rural) were initially selected for the larger case detection study. The rural regions were Siaya and Kombewa Health Demographic and Surveillance System Area (HDSA); the urban regions were Kisumu Town East and Kisumu Town West. Kombewa's HDSA is located within Kisumu County while Siaya's HDSA is located within Siaya County.

Siaya and Kombewa region is constructed within previously defined DSSs, and areas within it have been well characterized, and most residential compounds geocoded [38, 39]. Urban areas were selected from the most densely populated areas of Kisumu Township and residences of persons registered for TB after deployment of study interventions were later geocoded [29]. The Kaloleni sub-location was excluded from this study, as it lied between the 2 largest hospitals in the Kisumu area, the Jaramogi Oginga Odinga Teaching, and Referral Hospital (JOOTRH) and the Kisumu District General Hospital (KDH) which has been renamed Kisumu East County hospital [30]. Each region was subdivided into 6 units that represented contiguous locations with approximately 25,000 persons; there were a total of 24 units. Units were stratified into rural and urban and within each stratum, units were randomized to either implement or not to implement an intervention.

2.6. Implementation

The randomization sequence was generated by the study statistician based on these probabilities without the knowledge of the investigators prior to study implementation. A waiver of informed consent was sought from the Kenya Medical Research Institute because participation in this study, presented only a minimal risk for participants, would not alter rights of participants who would continue to receive services as per the existing policies and guidelines, would lead to timely diagnosis of TB as interventions implemented in the study would employ the use of more sensitive tests and, and it would be impractical to conduct with study with individual informed consent as the study aimed to compare the programmatic utility of different TB case detection strategies.

Among the 12 urban units, 6 were randomly assigned to have the 3 enhanced health-facility conditions (H, HC, HCM). In the 6 units with enhanced health-facility conditions, 2 were randomly assigned condition H, 2 were assigned condition HC, and 2 were assigned condition HCM. Among the remaining 6 rural units, 2 were randomly assigned condition S, 2 were assigned condition C, and 2 were assigned condition M. The same allocation procedure was used

to assign interventions to the 12 rural units. However, for this analysis, Siaya was excluded due to other on-going TB control activities in the region that limited the scope of the TB case detection strategy and leading to an imbalance of randomization of strategies for the rural units.

2.7. Intervention

The TB case detection study utilized 3 different strategies to enhance TB case detection namely;

- Household contact investigation (C): all patients diagnosed with TB were asked to elaborate a list of household members who would all undergo evaluation for TB.
- Facility-based active case finding (H): this involved the identification of all patients who screened positive for TB symptoms from all outpatient and inpatient departments and screening them for TB using sputum smear and Cepheid gene Xpert.
- Community-based active case finding using Mobile units (M): a mobile field site was established to move around selected communities to assess patients for TB symptoms and collect sputum specimens. The unit located itself within a particular area within the community for two weeks at a time and rotated throughout the community to be within a 2 km radius of every person within the community.
- The standard approach (S): in this group, there was no intervention. The program continued to diagnose patients as per their usual practice which was primarily based on the Directly Observed Treatment Short Course DOTS system of the passive finding of patients and confirmation of TB based sputum smear microscopy. Zones in the Standard Approach i.e. Contact invitation provided suitable control sites to compare the TB contact investigation study.

The strategies were combined as follows: Standard of care (S), Health facility screening (H), Community based mobile screening units (M), Contact investigations (C), Contact investigations and Health facility screening (HC), and all three the three strategies (HCM).

2.8. Outcomes

This study will describe the value of a TB contact screening strategy (e.g. contact investigation or contact invitation) as for changes in TB control achieved by that specific contact screening strategy. Cost comparisons are only possible if the program is mature, economic costs are well quantified and comparisons can be made across groups [40]. The TB program in Kenya has provided clear guidelines for the screening of household contacts [41]. However, this is limited by the fact that contact invitation rather than contact investigation is practiced in Kenya. As contact investigation is yet to be standardized in Kenya, an economic comparison between the two strategies would not be done (Tuberculosis, Leprosy, and Lung Diseases Coordinator, Personal Communication, 30th August 2012).

This study adopted the WHO TB control targets to define TB control i.e. TB control was defined in terms of the number of TB cases diagnosed among children aged less than 5 years, and the number of child contacts who have been exposed to an infectious case of TB who receive IPT [42]. The TB treatment outcomes will not be assessed as no further intervention will be provided in either group (contact investigation or contact screening) outside that which is received during routine care by the national TB control program after TB diagnosis. Although the outcome of IPT use that ought to be assessed is a decrease in TB incidence among children who received IPT; this would require a longer duration of follow up and a comparator group to assess the risk reduction accorded by IPT [43].

The outcome was measured at cluster-level. This was the number of TB cases diagnosed and persons who received IPT at health facilities randomized to a specific TB case detection strategy as reported by the TB program in the pre- and post-intervention period. The outcome of interest was the comparison of both the number of TB cases diagnosed among children aged less than 5 years and, number of children aged less than 5 years who received IPT in (i) the pre-intervention

2.9. Data collection

Electronic data was extracted from the Kisumu County TB program databases. The following variables were collected from each arm; the number of TB cases diagnosed, and the number of children put on IPT before and after the commencement of the study. This information was obtained from the TB program registers in the year preceding the study and during the conduct of the study.

2.10. Data analysis

Definitions of parameters of interest

The contact investigation strategy was comprised of either a contact investigation strategy in isolation (where the health facility only conducted contact investigation), or a contact investigation strategy in combination with other TB case detection strategies (where a health facility implemented contact investigation in combination with either enhanced facility case detection strategy, or community mobile units or both). The contact invitation strategy was represented by health facilities where the standard case approach was used. Health facilities that were randomized to other TB case detection strategies that did not include contact investigation were excluded from the analysis i.e. either mobile units or enhanced facility detection in isolation or in combination

A TB case was described as an individual aged less than 5 years entered in the TB program register between the 1st of January 2012 and 31st of December 2013 for the pre-intervention year, and between 1st of January 2014 to the 31st of December 2015 for the intervention years. A child who received IPT was described as an individual aged less than 5 years entered in the IPT register between the 1st of January 2012 and 31st of December 2013 for the pre-intervention year, and between 1st of January 2014 to the 31st of December 2015 for the intervention years.

The dependent variable was TB control as measured by the number of TB cases detected (as a proxy for a decrease in morbidity and mortality from TB), and the number of children who received IPT to prevent TB (as a proxy for a decrease in TB incidence and prevalence).

The independent variable was the TB contact screening strategy which was either contact investigation or contact invitation (a.k.a. the Standard approach).

The CONSORT flow diagram was used to illustrate the progress of randomized units from randomization, intervention, and analysis [26]. Health facilities randomized to a contact investigation strategy were compared to those randomized to the standard approach in terms number, age group and gender of TB cases diagnosed in the pre-intervention years, type and rural and urban distribution of health facilities to assess for balance of randomization between the groups and limit chances of systematic error, using chi-square statistics [44].

Since the population sizes and TB case rates in the randomized populations were intended to be the same, the total number of cases reported during the intervening years was compared to pre-intervention years. The change in detection in each arm was also compared between arms.

Fishers' exact test was used to compare the number of TB cases diagnosed in the pre-intervention year by the arm and the pre- and post-intervention years. Similarly, analyses were conducted for the number of children who received IPT [45].

3. Results

3.1. Results of randomization of health facilities

Of 86 facilities identified for the study, 65 were randomized to a contact screening strategy. The majority (54) were randomized to a TB contact investigation strategy in isolation (n=4), or in combination with health facility screening (n=19), or in combination with both enhanced facility screening and mobile units (n=31) with the remainder, (n=11) randomized to the standard approach i.e. TB contact invitation. Clinics that were randomized to other strategies (e.g. mobile units (n=6) or enhanced health facility screening (n=14) in isolation or combination were excluded from the analysis (Figure 2)

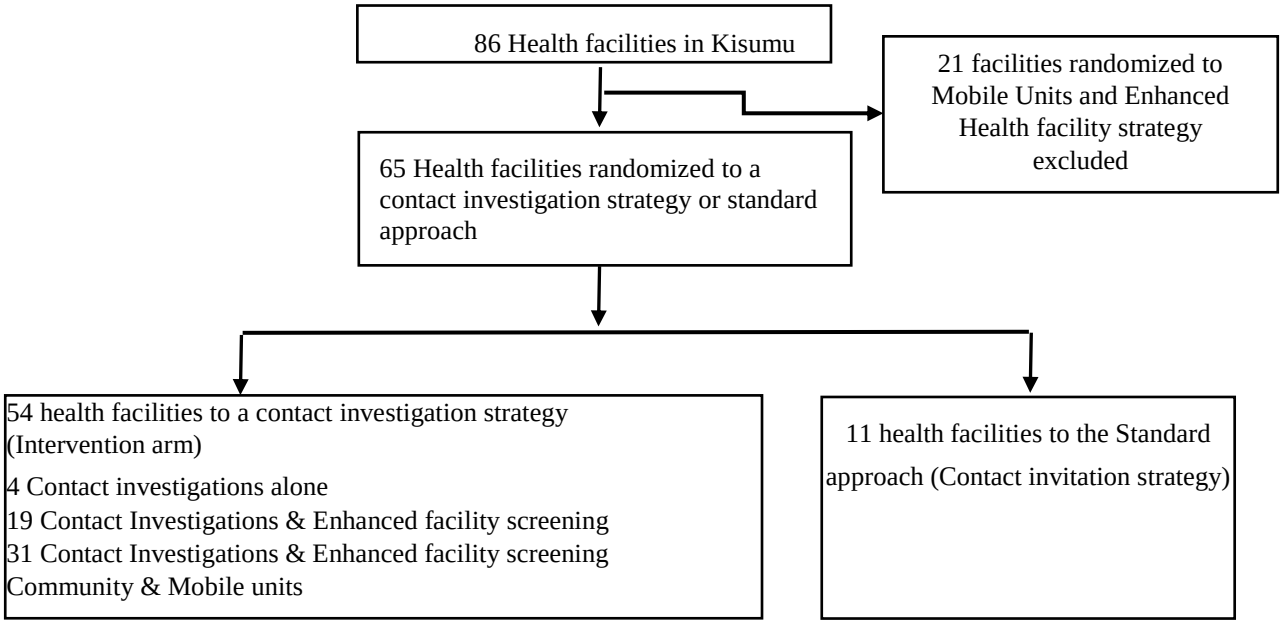


Figure 2: Randomization of health facilities to different strategies

3.2. Baseline characteristics of health facilities by strategy

Of 65 health facilities included, the majority were of level 2 (69%), located in urban areas (64%) and had a majorly male (56%) adult patients (91%). No facility was randomized to the Standard approach in rural locations. Facilities distribution did not differ by category of services or patient type (Table 1)

Table 1: Health facilities distribution to TB case detection strategies[¥]

Characteristics	No. of facilities	Contact investigation	Standard approach	P-value
	Total 65 (100%) n (%)	54 (83%) n (%)	11 (17%) n (%)	
Health Facility				
Facilities level				
2	45 (69)	38 (84)	7 (16)	0.18
3	16 (25)	14 (88)	2 (12)	
4 & 5*	4 (16)	2 (50)	2 (50)	
Distribution				
Rural	21 (33)	22 (100)	0 (0)	-

Urban	44 (67)	33 (75)	11 (25)	
TB cases in 2013 & 2012	N=2713	N=1879	N=834	
Age groups				
<5 years	95 (4)	62 (65)	33 (35)	0.36
5-14	123 (4)	79 (64)	43 (36)	
15+ years	2495 (92)	1738 (70)	757 (30)	
Gender				
Male	1546 (57)	1073 (69)	473 (31)	0.88
Female	1167 (43)	806 (69)	361 (31)	

¥ Column percentages used throughout the table

*Levels grouped to eliminate cells containing zero, contact investigation facilities have 1 level 4 and 0 levels 5 facilities, and Standard approach has 2 level 4 and 1 level 5 facility

3.3. Assessment of TB control activities

In the pre-intervention and post-intervention years

The number of TB cases increased by 20; the majority were from the contact investigation arm (15/20; 75%) while the minority were from the contact invitation arm (5/20; 52%). This increase was not statistically significant.

A before and after comparison of IPT administration could not be done since IPT implementation at all health facilities was not initiated until 2014. (Table 2)

During study implementation by TB case detection strategy

Between 2014 and 2015, there was a decrease in TB cases by 17 (12 from the Standard approach and 5 from the contact investigation arm); but this was not statistically significant (Table 2).

During the intervening years, health facilities randomized to the intervention arm contributed to 100% and 75% (49/65) of the children put on IPT in 2014 and 2015 (Table 2).

Table 2: TB control in children by TB case detection strategy

The measure of TB control	**Strategy**				Total	P-value
	Contact investigation in isolation or combination with other strategies			Standard Approach		
	C	HC+HCM	Total			
TB cases diagnosed						0.28†
Pre-intervention years-Total	8	54	62 (65)	33 (35)	95 (100)	
2012	5	20	25	15	40	
2013	3	34	37	18	55	
Post-Intervention Years-Total	4	74	77 (73)	28 (27)	105 (100)	0.12††
2014	1	40	41	20	61	
2015	3	33	36	8	44	
Children on IPT						
Pre-intervention years*-Total	-	-	-	-	-	-
2012	-	-	-	-	-	
2013	-	-	-	-	-	
Post-intervention years **-Total	-	49	49 (75)	16 (25)	65 (100)	
2014	-	2	2 (100)	-	2 (100)	-
2015	-	47	47 (72)	16 (28)	63 (100)	

C-contact investigation, HC-contact investigation+ enhanced facility screening, HCM- contact investigation+ enhanced facility screening+ Community Mobile Units, S-Standard Approach (Contact Invitation)
† P value comparing TB cases diagnosed in the pre and post-intervention period by the arm
†† p-value comparing TB cases diagnosed in the intervention period by the arm
*IPT implementation had not formally begun during the pre-intervention years
** Comparison by arm not done during intervention years as no children received IPT in 2014 in the standard arm

4. Discussion

We set out to compare the yield of TB contact investigation to contact invitation in childhood TB control. Data analysis and interpretation revealed three major findings. The number of children diagnosed with TB increased during the intervention years compared to the pre-intervention years. During the intervening years, the number of TB cases diagnosed at health facilities that were implementing a contact investigation strategy was higher than that at health facilities implementing a contact invitation strategy. In the intervention years, health facilities implementing a contact investigation strategy had a higher number of children that were put on IPT compared to facilities implementing a contact invitation strategy. Although a limited number of children were put on IPT in the first year of the post-intervention phase, this could be attributed to erratic IPT supply, and challenges in the documentation. (Personal communication, CTLC Coordinator, 10th December 2018)

There was an increase in the number of TB cases and children put on IPT before and after the implementation of the study. In the literature, it has been established that Contact investigation leads to an increase in both the number of TB cases detected among children aged less than 5 years, as well as the number of children that were put on IPT [25]. Although all TB Case detection strategies have also been shown to increase TB case detection [13], cluster-randomized strategies have shown different yields between different TB case detection strategies with sometimes conflicting results. Over four years, the ZAMSTAR study showed a higher decrease in TB burden among persons randomized to a household strategy compared to those randomized to a community-level enhanced case-finding strategy where health education was given [13]. Contrary to this, the DETCT TB study in Zambia showed a higher yield among persons randomized to a mobile van unit compared to a household strategy. In the literature, mobile outreach services have been known to provide a higher yield. Although the authors state that the mobile unit may be associated with stigma since consultation occurs in front of others, the study did not investigate the preference for the mobile unit [46].

A Brazilian trial also showed a preference for a door-to-door strategy compared to a mobile van unit. The authors suggested that this could be because the effect of health education may take longer to motivate community members to change their health behavior [47]. Both studies proposed that household models led to personalized interaction, supported persons to assess their risks of infection and eased linkage to essential health services [13, 47]; these reasons apply to both household and enhanced facility screening strategies. However, such persons may have still presented to the clinic for screening in the absence of this study [12]. A combination of these reasons may have been responsible for the increase in TB CDR in the combined strategies. However, this study was unable to track participants over a long duration to assess the impact of IPT initiation. The study did also not enquire about the preference for a specific TB case detection strategy.

The results of this study are generalizable to other TB clinics in Kenya. The clinics randomized to the intervention arm did not differ from those that were randomized to the control arm [31]. The study employed a cluster randomized controlled trial which are powerful means of measuring the

effectiveness of interventions; the level of evidence generated by randomized controlled trials is ranked higher than case-control or cohort studies [25]. The before and after comparison allowed for an assessment of the intervention over a longer period in which changes in the TB policies and guidelines would have impacted on the outcomes in both the intervention and control arms [32]. Although the difference in TB cases diagnosed did not achieve statistical significance, this was of clinical significance.

Our evaluation was not without limitations. Due to the limited numbers of children diagnosed with children within each specific strategy, we were unable to make a direct comparison of the yield of different TB case detection strategies when compared with the standard approach. Although the health facilities were not balanced in terms of rural and urban distribution, this was not a basis for comparison of study outcomes. Therefore, further analysis of the effect of balance was not conducted [44].

In conclusion, contact investigation provided the dual benefit of increasing TB case detection & the opportunity to provide IPT and therefore impacting the burden of TB in childhood in Kisumu County. Timely TB diagnosis contributes to better treatment outcomes and therefore a decrease in morbidity and mortality from TB. TB prevention therapy contributes to a decrease in TB incidence and prevalence. Together, these two contribute to TB control in childhood.

We, therefore, recommend that TB programs implement TB Contact investigation among child household members that have been shown to enhance TB control activities in children in this region. Further research should be conducted to: Investigate acceptably and high-yield TB case-finding strategies.

Data availability: The number of Tuberculosis patients or TB exposed children on IPT data used to support the findings of this study are available from the corresponding author upon request.
Conflict of interest: None

References

[1] Porter, M.E., "What Is Value in Health Care?". *New England Journal of Medicine*, **363,** 2477-2481, 2010.

[2] Volpp, K., G. Loewenstein, and D. Asch, "Assessing value in health care programs". *JAMA*, **307,** 2153-2154, 2012.

[3] Dowdle, W.R., "The principles of disease elimination and eradication". *Bulletin of the World Health Organization*, **76 Suppl 2,** 22-25, 1998.

[4] Dye, C., M. Hosseini, and C. Watt, "Did we reach the 2005 targets for tuberculosis control?". *Bull World Health Organ*, **85,** 364-9, 2007.

[5] World Health Organization *Implementing the End TB Strategy: The essentials*. https://www.who.int/tb/publications/2015/The_Essentials_to_End_TB/en/

[6] Murray, C.J.L. and J.A. Salomon, "Expanding the WHO tuberculosis control strategy: rethinking the role of active case-finding [The Pittsfield Lecture]". *Int J Tuberc Lung Dis*, **2,** 9-15, 1998.

[7] Erkens, C.G., et al., "Tuberculosis contact investigation in low prevalence countries: a European consensus". *Eur Respir J*, **36,** 925-49, 2010.

[8] MacIntyre, C.R. and A.J. Plant, "Impact of policy and practice on the effectiveness of contact screening for tuberculosis". *Prev Med*, **27,** 830-7, 1998.

[9] Guwatudde, D., et al., "Tuberculosis in household contacts of infectious cases in Kampala, Uganda". *Am J Epidemiol*, **158,** 887-98, 2003.

[10] Sloot, R., et al., "Risk of Tuberculosis after Recent Exposure. A 10-Year Follow-up Study of Contacts in Amsterdam". *American Journal of Respiratory and Critical Care Medicine*, **190,** 1044-1052, 2014.

[11] Banu Rekha, V.V., et al., "Contact screening and chemoprophylaxis in India's Revised Tuberculosis Control Programme: a situational analysis". *Int J Tuberc Lung Dis*, **13,** 1507-12, 2009.

[12] Becerra, M.C., et al., "Expanding tuberculosis case detection by screening household contacts". *Public Health Rep*, **120,** 271-7, 2005.

[13] Ayles, H., et al., "Effect of household and community interventions on the burden of tuberculosis in southern Africa: the ZAMSTAR community-randomized trial". *Lancet*, **382,** 1183-94, 2013.

[14] Singh, M., et al., "Prevalence and risk factors for transmission of infection among children in household contact with adults having pulmonary tuberculosis". *Arch Dis Child*, **90,** 624-8, 2005.

[15] World Health Organization *Recommendations for investigating contacts of persons with infectious Tuberculosis in low and middle-income countries*. http://apps.who.int/iris/bitstream/10665/77741/1/9789241504492_eng.pdf?ua=1

[16] World Health Organization *A brief history of Tuberculosis in Kenya*. https://www.who.int/tb/publications/tb-kenya-report/en/

[17] Division of Leprosy Tuberculosis and Lung Diseases Program *Annual Report 2012*. https://www.nltp.co.ke/annual-reports/#

[18] National Tuberculosis Leprosy and Lung Disease Program *Annual Report 2016*. https://www.nltp.co.ke/annual-reports/

[19] National AIDS and STI Control Program NASCOP *Kenya AIDS Indicator Survey 2012: Final Report*. http://nacc.or.ke/wp-content/uploads/2015/10/KAIS-2012.pdf

[20] Division of Leprosy Tuberculosis and Lung Diseases Program *Annual Report 2010*. https://www.nltp.co.ke/annual-reports/

[21] Division of Leprosy Tuberculosis and Lung Diseases Program *Guidelines for Management of Tuberculosis and Leprosy in Kenya*. http://guidelines.health.go.ke:8000/media/TB_Treatment_GUIDELINES_2013.pdf

[22] Chakhaia, T., et al., "High Utility of Contact Investigation for Latent and Active Tuberculosis Case Detection among the Contacts: A Retrospective Cohort Study in Tbilisi, Georgia, 2010–2011". *PLOS ONE*, **9,** e111773.2014.

[23] Chafe, R., "The Value of Qualitative Description in Health Services and Policy ResearchValeur de la description qualitative dans la recherche sur les politiques et services de santé". *Healthcare policy = Politiques de sante*, **12,** 12-18, 2017.

[24] Kenya National Bureau of Statistics *2009 Population and Housing Census*. https://www.knbs.or.ke/publications/

[25] Fox, G.J., et al., "Contact investigation for tuberculosis: a systematic review and meta-analysis". *Eur Respir J*, **41,** 140-56, 2013.

[26] Schulz, K.F., et al., "CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials". *Int J Surg*, **9,** 672-7, 2011.

[27] Kenya Law *Constitution of Kenya*. www.kenyalaw/org/lex/act view.xql?actid=Const2010

[28] Ministry of Health *Kenya Health Sector Strategic Investment Plan (KHSSPI) July 2013-June 2017*. http://e-cavi.com/wp-content/uploads/2014/11/kenya-health-sector-strategic-investiment-plan-2013-to-2017.pdf

[29] County Government of Kisumu *Kisumu County: First County Integrated Development Plan 2013-2017*. https://roggkenya.org/wp-content/uploads/Kisumu_CIDP_2018-2022_County-Integrated-Development-Plan.pdf

[30] Ministry of Health *Kenya Master Facility List*. http://kmhfl.health.go.ke/

[31] Bruce, N.G., C. Pope, and D. Stanistreet, *Quantitative methods for health research: A practical interactive guide to epidemiology and statistics*. John Wiley Chichester. 2008

[32] Younge, J.O., et al., "Randomized study designs for lifestyle interventions: a tutorial". *International Journal of Epidemiology*, **44,** 2006-2019, 2015.

[33] Whitley, E. and J. Ball, "Statistics review 4: sample size calculations". *Crit Care*, **6,** 335-41, 2002.

[34] Borgdorff, M.W., "New measurable indicator for tuberculosis case detection". *Emerg Infect Dis*, **10,** 1523-8, 2004.

[35] National Tuberculosis Leprosy and Lung Disease Program *Kenya Tuberculosis Prevalence Survey 2016*. https://www.chskenya.org/wp-content/uploads/2018/04/Final-TB-Prevalence-Survey-Report.pdf

[36] Speak, A., et al., "Comparing convenience and probability sampling for urban ecology applications". *Journal of Applied Ecology*, **55,** 2332-2342, 2018.

[37] World Health Organization *Road Map for Childhood Tuberculosis*. http://apps.who.int/iris/bitstream/10665/89506/1/9789241506137_eng.pdf?ua=1&ua=1

[38] Sifuna, P., et al., "Health & demographic surveillance system profile: The Kombewa health and demographic surveillance system (Kombewa HDSS)". *Int J Epidemiol*, **43,** 1097-104, 2014.

[39] Odhiambo, F.O., et al., "Profile: the KEMRI/CDC Health and Demographic Surveillance System--Western Kenya". *Int J Epidemiol*, **41,** 977-87, 2012.

[40] Issel, L.M., *Health program planning, and evaluation: a practical, systematic approach for community health*. Jones and Bartlett Publishers Sudbury, Mass. ; London. 2004

[41] Division of Leprosy Tuberculosis and Lung Diseases Program, *National Paediatric Tuberculosis Care Guidelines*. Division of Leprosy, Tuberculosis, and Lung Diseases Nairobi Kenya. 2011

[42] Azman, A.S., J.E. Golub, and D.W. Dowdy, "How much is tuberculosis screening worth? Estimating the value of active case finding for tuberculosis in South Africa, China, and India". *BMC Med*, **12,** 216, 2014.

[43] Golub, J.E., et al., "Long-term protection from isoniazid preventive therapy for tuberculosis in HIV-infected patients in a medium-burden tuberculosis setting: the TB/HIV in Rio (THRio) study". *Clin Infect Dis*, **60,** 639-45, 2015.

[44] Festic, E., B. Rawal, and O. Gajic, "How to improve assessment of balance in baseline characteristics of clinical trial participants-example from PROSEVA trial data?". *Annals of translational medicine*, **4,** 79-79, 2016.

[45] Parab, S. and S. Bhalerao, "Choosing statistical test". *International Journal of Ayurveda research*, **1,** 187-191, 2010.

[46] Corbett, E.L., et al., "Comparison of two active case-finding strategies for community-based diagnosis of symptomatic smear-positive tuberculosis and control of infectious tuberculosis in Harare, Zimbabwe (DETECTB): a cluster-randomized trial". *Lancet*, **376,** 1244-53, 2010.

[47] Miller, A.C., et al., "Controlled trial of active tuberculosis case finding in a Brazilian favela". *Int J Tuberc Lung Dis*, **14,** 720-6, 2010.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.06

IJHSRP

Research Article

EFFECT OF LONELINESS IN THE WORKPLACE ON EMPLOYEES' JOB PERFORMANCE: A STUDY FOR HOSPITAL EMPLOYEES

Serkan DENİZ*[1]

[1]Yalova University, Termal Vocational School, Yalova, Turkey

* Corresponding author; serkand100@gmail.com

Abstract: *Loneliness has become one of the most important problems of our time. Loneliness can be seen not only in daily life but also in the workplaces. Loneliness in the workplace has many negative effects on both employees and organizations. In this study, it was aimed to reveal the effect of loneliness in the workplace on the job performance of employees in terms of private hospitals. The study was held in Istanbul, Turkey from August 2019 to October 2019. The data of the study were collected from the employees of the private hospitals operating in Istanbul through the survey method. 393 valid questionnaires were collected for the study. When the study was completed, the loneliness levels of the participants in the workplace were found to be generally low and their job performances were to be high. As a result of the study, it was found that there is a statistically significant, negative and moderate relationship between all dimensions of loneliness in the workplace and the employees' job performance. Also, it was found that all dimensions of loneliness in the workplace negatively affect the job performance of employees. The results of this study indicate that loneliness in the workplace is a determinant for the employees' job performance According to the results of the study, hospital managements were suggested to carry out some studies in order to ensure that employees do not experience loneliness in the workplace and to improve their job performance.*

Keywords: *Loneliness, Workplace, Job, Performance*

Received: November 1, 2019 Accepted: November 29, 2019

1. Introduction

People need to interact and communicate with each other throughout their lives [1]. The social relationships and interactions to be established enable people to meet their psychosocial needs. Although people and communities have become closer to each other due to the impact of developments in communication and information technologies, they cannot meet their psychosocial needs because these technological developments lead people to establish virtual and superficial relationships instead of real social relations and interactions [2]. Besides, many factors such as changes in family structure, migrations, increase in urbanization, changes in working and living conditions and globalization prevent people from meeting their psychosocial needs. Failure to meet psychosocial needs has negative effects on people. One of these effects is that people become lonely.

Loneliness is defined as a disturbing psychological condition that a person is exposed to because of the inability to reach the desired level of social intercourse [3]. According to another definition, loneliness is a negative psychological state caused by the perception of the lack of satisfactory social relationships [4]. Loneliness, according to another definition, is a state of cognitive and sensory strain

that results from the mutual interaction of personal and environmental factors that causes people to suffer, disappoint them, and destroy their hopes [5]. Loneliness refers to a mental state and a state of mind originating from being away from mutual social interaction rather than physical distances from each other [6]. Loneliness can lead people to feel unhappy and insecure, to be depressed, to become more sensitive to threats and to exhibit hostile attitudes towards their environment, and may cause social adversity as it negatively affects the social interaction of people [7].

The phenomenon of loneliness is not only limited to the general life of the people but can also be seen in the workplace [3]. The concept of loneliness in the workplace, which has emerged with industrialization and creates awareness, has become a reality that is no longer ignored in today's working life [8]. Loneliness in the workplace has many negative effects on organizations. Employees' job performance is considered as one of these effects. In this study, it was aimed to reveal the effect of loneliness in the workplace on the employees' job performance in terms of private hospitals.

2. Literature Review

2.1. Loneliness in the Workplace

The concept of loneliness in the workplace refers to the emotional and social loneliness of an employee in the organization [9]. Unlike general loneliness, loneliness in the workplace is effective only in the working environment. In other words, an individual who has satisfactory and healthy relationships in daily life and does not experience loneliness may have problems in establishing and maintaining social relations in the workplace. This situation may lead an individual to experience loneliness in the workplace [10].

According to Wright et al. [11], loneliness in the workplace has two dimensions including emotional deprivation and social companionship. In the dimension of emotional deprivation, the employee has dominant thoughts of shutting himself/herself down to colleagues, avoiding sharing feelings and thoughts with them and not to be understood by them. Employees experiencing emotional deprivation in the workplace give the impression that they keep their colleagues at a distance, feel excluded from the group and experience a general feeling of emptiness. The social companionship dimension includes the fact that the employee does not participate in the social network in the organization and does not see himself or herself as a part of the social network in the organization. Employees who cannot communicate easily with their colleagues and do not participate in social activities may experience loneliness in the dimension of social companionship. Lack of communication is the most important reason for loneliness in this dimension [6].

Other employees in the organization can identify employees who experience loneliness in the workplace as having problems in establishing social relations, with a low level of self-confidence, shy and misfit persons [2]. Many factors are effective in experiencing loneliness in the workplace. Personality characteristics of employees, working values, quality of work, working hours, workload, attitudes and behaviors of managers, organizational support, organizational culture, organizational climate, human resources policies are major factors [2-12].

Loneliness in the workplace has many negative effects on both employees and organizations. According to the studies in the literature, loneliness in the workplace leads to reduced life satisfaction and job satisfaction of employees, leader-member interaction [13], perceived manager support [14], organizational citizenship behavior [4], work performance and work efficiency [15]. On the other hand,

loneliness in the workplace can lead to increases in the intention of employees to quit [3-16], organizational cynicism [14] and organization alienation [17]. In addition, loneliness in the workplace can cause stress in employees [18] and impaired health [12]. Negative effects of loneliness in the workplace affect also the success of the organization and peace in the workplace [19].

2.2. Employees' Job Performance

In today's fierce competition environment, many factors are effective for organizations to gain competitive advantage and survive. One of these factors is the employees and especially the qualifications and performance of the employees have become very important for the organizations. Organizations need high-performing employees to achieve their goals and objectives, gain competitive advantage, and survive [20]. Employees with high job performance increase also the performance of organizations. The high performance of organizations increases the competitiveness level of organizations and ensures the sustainability of organizations [21].

Performance is demonstrating behaviors that meet the standards specified to achieve the goals or objectives and the level of achievement of the goals or objectives [22]. According to another definition, performance is the degree of planned activity to achieve the goals or objectives [23]. And employees' job performance is conceptualized as actions and behaviors that are under the control of employees and contribute to the realization of organizational goals and objectives [24]. Employees' job performance is defined as, besides their actions and efforts to accomplish their tasks, the degree of performing their tasks or achieve their goals and objectives as a result of these actions and efforts [25].

Borman and Motowidlo [26] consider the employees' job performance in two dimensions including task performance and contextual performance. Task performance is the success of employees in fulfilling the tasks specified in the job definition. The main determinants of task performance are the professional knowledge, skills, and experiences of the employee [27]. The contextual performance involves volunteering, helping other employees, and collaborating with other employees to complete other works in the organization during carrying out jobs not specified in the job definition [26].

Employees' job performance can be affected by many factors. When reviewing the studies in the literature, factors such as job satisfaction [28-29], organizational commitment [30], organizational citizenship behavior [31], perceived organization support [32-33], organizational trust [34], motivation [35], perception of ethical leadership [36] affect the employees' job performance in positive manner. Whereas factors such as work overload [31], organizational cynicism [37-38], mobbing [39] affect the employees' job performance negatively.

To keep the employees' job performance at the top level, organizations should constantly monitor the factors that affect job performance positively or negatively. Besides, a working environment should be created where employees find their job meaningful, feel themselves competent and comfortable, salaries should be fair, promotions should be made in a timely and correct manner, necessary rewards should be provided, social rights and opportunities should be provided, employees should be given close attention, employees' ideas and thoughts should be respected, ensure their participation in organizational decisions and establish a system for continuous improvement of performance [40-41].

2.3. Hypotheses of the Study

The negative effects of loneliness in the workplace on employees and organizations were mentioned above. Employees' job performance is considered one of the issues negatively affected by loneliness in the workplace. The hypotheses of the study developed by considering both this consideration and the objective of the study are as follows:

H1. There is a negative relationship between loneliness in the workplace and employees' job performance.

H2. Loneliness in the workplace negatively affects the employees' job performance.

3. Methods

The study was held in Istanbul, Turkey from August 2019 to October 2019. The data of the study were collected through the survey method. 393 valid ones of the collected questionnaire forms were used for statistical analysis purposes.

3.1. Sample

Most of the private hospitals are operated in Istanbul. Therefore, the study was held in Istanbul. The data of the study were collected from the employees of the private hospitals operating in Istanbul. The data of the study were collected from different professional groups including physicians, staff working in administrative units (accounting, human resources, patient admission, etc.), health personnel (midwives, nurses, labs, etc.), technical and support personnel (electric technicians, security, drivers, etc.). The sample size that can represent the population of the research was determined as 384 people in a 95% confidence interval [42]. 393 valid questionnaires were collected for the study.

3.2. Data Collection Tool

The questionnaire used to collect data for the study consists of three sections. The first section of the questionnaire contains questions to determine the demographic characteristics of the participants. The second section includes questions to determine the level of loneliness in the workplace. In the second section, the Loneliness at Work Scale – LAWS prepared by Wright et al [11] was used. The scale consists of two dimensions and 16 items including emotional deprivation (9 items) and social companionship (7 items). Turkish validity and reliability study of the scale was conducted by Doğan et al. [10]. The third section includes expressions to determine the employees' job performance. The "Performance Scale" prepared by Tayfun and Çatır [43] and consisting of 6 expressions was used in the third section.

The expressions used in the scales were measured with 5-point Likert-type scale options. When an average score to be obtained from the "Loneliness at Work Scale" approaching 5 indicates that the loneliness in the workplace is high and the average score to be obtained from the "Performance Scale" approaching 5 indicates that the employees' job performance is high. Cronbach's Alpha coefficients calculated to determine the reliability level of the scales used in the study are shown in Table 1. The results in Table 1 show that both scales are reliable.

Table 1. Reliability Analysis

Dimensions	Number of Items	Cronbach's Alpha
Emotional Deprivation	9	0.88
Social Companionship	7	0.85
Loneliness in the Workplace	**16**	**0.92**
Employees' Job Performance	**6**	**0.69**

3.3. Data Analysis

SPSS 23.0 statistical program suite was used for the analysis of the data collected for the study. Descriptive statistics were calculated to determine the level of loneliness and the job performance of the participants in the workplace. Correlation analysis and multiple linear regression analyses were performed to determine the relationships between loneliness in the workplace and employees' job performance. The results obtained from the analyses were evaluated at a 95% confidence interval and a 5% significance level.

4. Results

Findings obtained as a result of data analyses are as follows.

Table 2. Demographics Characteristics of Participants

Demographic Variables		Frequency (n=393)	%
Gender	Female	291	74.0
	Male	102	26.0
Age	≤ 25	160	40.7
	26-35	150	38.2
	≥ 36	83	21.1
Education Status	High School	74	18.8
	Associate Degree	120	30.5
	Undergraduate Degree	147	37.4
	Graduate Degree	52	13.2
Position	Administrative Personnel	202	51.4
	Health Personnel	135	34.4
	Physician	16	4.1
	Technical or Support Staff	40	10.2
Working time in the Hospital	≤ 5 Years	295	75.1
	6-10 Years	61	15.5
	≥ 11 Years	37	9.4

Table 2 shows the demographic characteristics of the participants. Of the participants, 291 (74.0%) are female while 102 (26.0%) are male. Participants include 160 people (40.7%) in the 25 or

below age range, 150 people (38.2%) in the 26-35 age range and 83 people (21.1%) in the 36 or above age range. Of the participants, 74 (18.8%) have a high school degree, 120 (30.5%) have associated degrees, 147 (37.4%) undergraduate degrees and 52 (13.2%) have a graduate degree. The tasks of the participants were classified under four titles. Of the participants, 202 (51.4%) were administrative personnel, 135 (34.4%) were health personnel, 16 (4.1%) were physicians and 40 (10.2%) were technical or support staff. Of the participants, 295 (75.1%) have a working time of 5 years or less, 61 (15.5%) have a working time of 6 to 10 years and 37 (9.4%) have a working time of 11 years and more.

Table 3. Descriptive Statistics

Variables	n	M	SD	Skewness	Kurtosis
Emotional Deprivation	393	2.26	0.71	0.51	0.13
Social Companionship	393	2.25	0.73	0.70	0.69
Loneliness in the Workplace	**393**	**2.25**	**0.67**	**0.63**	**0.51**
Employees' Job Performance	**393**	**4.07**	**0.54**	**-0.40**	**1.02**

**M= Mean, SD= Std. Deviation*

According to Table 3, the level of loneliness of the participants regarding the emotional deprivation *(M= 2.26, SD=0.71)* and social companionship *(M= 2.25, SD=0.73)* dimensions as well as loneliness in the workplace in general *(M= 2.25, SD=0.67)* was found to below. Also, according to the Table, the participants' job performance *(M=4.07, SD=0.54)* was found to be high.

Table 4. The Relationship Between Loneliness in the Workplace and the Employees' Job Performance

Variables	1	2
(1) Emotional Deprivation		
(2) Social Companionship	.731**	
Employees' Job Performance	**-.422****	**-.482****

***p<0.01*

According to the results of the correlation analysis in Table 4, there is a statistically significant relationship between all dimensions of loneliness in the workplace and the employees' job performance ($p<0.01$). According to the correlation coefficients, there is a negative and moderate relationship between the employees' job performance and the dimensions of emotional deprivation *(r = -0.422)* and social companionship *(r = -0.482)*.

Table 5. Effect of Loneliness in the Workplace on Employees' Job Performance

Independent Variables	β	t	p	Tolerance	VIF
Constant		59.48	0.00		
Emotional Deprivation	-0.15	-2.31	0.02	0.46	2.15
Social Companionship	-0.37	-5.77	0.00	0.46	2.15
	F=62.46 p=0.00 R^2= 0.243				

Dependent Variable: Employees' Job Performance

According to the results of the regression analysis shown in Table 5, both the emotional deprivation dimension *(β=-0.15, p<0.05)* and the social companionship dimension *(β=-0.37, p<0.05)* have a negative effect on the employees' job performance. It was determined that 24.3% of the change in the employees' job performance was explained by the loneliness in the workplace (R^2=0.243). The results of this study indicate that loneliness in the workplace is a determinant of the employees' job performance.

5. Discussion and Conclusion

When the study was completed, the loneliness levels of the participants in the workplace were found to be generally low *(M= 2.25, SD=0.67)*. Findings of a similar study conducted by Amarat et al. [44] for hospital employees support this result as well. The findings of the studies conducted for non-health sectors also support this result [3-13]. Because the health sector is a labor-intensive, functional commitment among the employees, teamwork is necessary, the quality of the relations and communication among the employees of the sector is of great importance for the successful delivery of medical services. The loneliness of hospital employees in the workplace may cause problems in relations and communication between employees. This may adversely affect the quality and quantity of health services, and consequently affect patients, employees, hospitals, and society. Therefore, a low degree of loneliness in the workplace is desirable for hospitals.

Another result of the study is that the job performances are high according to the participants *(M=4.07, SD=0.54)*. The findings of similar studies conducted for the health sector support this result [45-46-47]. The high job performance of employees is desirable for labor-intensive hospitals. The high job performance of the employees in the hospitals improves the quality of health services, ensures patient satisfaction, improves the performance of the institution and ensures the competitive advantage and its continuity.

Through this study, it was aimed to reveal the effect of loneliness in the workplace on the employees' job performance in terms of private hospitals. Two study hypotheses have been developed for this purpose. According to the results of the analysis made to test hypotheses, it was found that there is a statistically significant, negative and moderate relationship between all dimensions of loneliness in the workplace and the employees' job performance (Table 4). Also, it was found that all dimensions of loneliness in the workplace negatively affect the job performance of employees. (Table 5). According to these results, both H1 and H2 hypotheses were accepted. The findings of similar studies for hospital employees support these results as well [44-48].

The results of this study indicate that loneliness in the workplace is a determinant for the employees' job performance According to the results of the study; hospital management is suggested to carry out some studies to ensure that employees do not experience loneliness in the workplace and to improve their job performance. In order to ensure that employees do not experience loneliness in the workplace, the hospital managements are recommended within this scope to take into consideration the social and family lives of employees, to strength the communication and cooperation between employees, to organize social activities and provide employee participation in these activities, to provide psychological support to employees when necessary, to ensure good time during breaks and to be fair in working conditions and and organizational practices. Periodical measurement of the employees' job performance, carrying out the necessary works to remove the factors that negatively affect the

employees' job performance, creating a healthy working environment, providing an effective reward mechanism, promotions, ensuring the organizational justice, creating an organizational culture that will encourage the performance improvement of employees and implementing methods and activities to improve the performance of employees are further recommended.

Although it is a limitation that this study was conducted with less number of employees, it is important to reveal the effect of loneliness in the workplace on the employees' job performance and the relationship between these variables in terms of private hospitals. It is considered that it would be beneficial to conduct similar studies with more employees and by including employees in public hospitals.

References

[1] Akçit, V., Barutçu, E., "The Relationship Between Performance and Loneliness at Workplace: A Study on Academicians", *European Scientific Journal,* Special Issue, 235-243, 2017.

[2] Eroğlu, Ş.G., "A Research on Relationship Between Perceived Supervisor Support and Workplace Loneliness", *Journal of Management, Economics and Marketing Research,* 2(1), 1-17, 2018. Doi: 10.29226/TR1001.2018.9

[3] Demirbaş, B., Haşit, G., "Loneliness at Workplace and Its Effect on the Intention to Leave: An Application on the Academicians", *Anadolu University Journal of Social Sciences,* 16(1), 137-158, 2016.

[4] Lam, L.W., Lau, D.C., "Feeling Lonely at Work: Investigating the Consequences of Unsatisfactory Workplace Relationships", *The International Journal of Human Resource Management,* 23(20), 4265-4282, 2012. http://dx.doi.org/10.1080/09585192.2012.665070

[5] Armağan, A., **"**Loneliness and Interpersonal Communication ability Relationship: A Research on University Students", *The Journal of International Social Research,* 7(30), 27-43, 2014.

[6] Mercan, N., Oyur, E., Alamur, B., Gül, S., Bengül, S., "A Resource on the Relationship Between Loneliness at Work and Social Phobia", *Organizasyon ve Yönetim Bilimleri Dergisi,* 4(1), 213-226, 2012.

[7] Çakır, V., Çakır, V., "Loneliness and Television Usage", *Journal of Selcuk Communication,* 7(1), 131-147, 2011.

[8] Parlak, Ö., Koçoğlu Sazkaya, M., "The Investigation of the effect of Five Factor Personality on Loneliness at Work", *Ordu University Journal of Social Science Research,* 8(1), 149-165, 2018.

[9] Aksoy, S., "The Mediating Role of Loneliness at Workplace on the Trust in Colleagues on Organizational Identification", *Business and Economics Research Journal,* 10(1), 203-218, 2019. doi: 10.20409/berj.2019.163

[10] Doğan, T., Çetin, B., Sungur, M.Z., "Reliability and Validity of the Turkish Version of Loneliness at Work Scale", *Anatolian Journal of Psychiatry,* 10, 271-277, 2009.

[11] Wright, S.L., Burt, C.D.B., Strongman, K.T., "Loneliness in the Workplace: Construct Definition and Scale Development", *New Zealand Journal of Psychology,* 35(2), 59-68, 2006.

[12] Zhou, X., "A Review of Researches Workplace Loneliness", *Psychology,* 9, 1005-1022, 2018. Doi: 10.4236/psych.2018.95064

[13] Cindiloğlu, M., Polatcı, S., Özçalık, F, Gültekin, Z., "The Effects of Workplace Loneliness on Job and Life Satisfaction: The Mediating Role of Leader-Member Exchange", *Ege Academic Review,* 17(2), 191-200, 2017. Doi: 10.21121/eab.2017225198

[14] Ece, S., Gültekin, S., "The Lonely Hearts in the Organizations: The Mediation Role of the Perceived Supervisor Support on the Cynical Attitudes of the Lonely Employees", *Turkish Studies*, 14(2), 355-370, 2019. Doi: 10.7827/TurkishStudies.14406

[15] Akgül, H., "An Investigation of Emotional and Social Loneliness Levels of Logistics Sector Employees in Terms of Some Variables", *The Journal of International Lingual, Social and Educational Sciences*, 3(2), 269-287, 2017.

[16] Kaymaz, K., Eroğlu U., Sayılar Y. "Effect of Loneliness at Work on the Employees' Intention to Leave", "Is Guc" *Industrial Relations and Human Resources Journal*, 16(1), 38-53, 2014. Doi: 10.4026/1303-2860.2014.0241.x

[17] Santas, G., Isik, O., Demir, A., "The Effect of Loneliness at Work; Work Stress on Work Alienation and Work Alienation on Employees' Performance in Turkish Health Care Institution", *South Asian Journal of Management Sciences*, 10(2), 30-38, 2016. Doi:10.21621/sajms.2016102.03

[18] Keser, A., Karaduman, M., "The Correlation Between Loneliness at Work-Life and Organizational Citizenship and A Research on Teachers", *HAK-İŞ International Journal of Labour and Society*, 3(7), 178-197, 2014.

[19] Akduru, H.E., Semercioöz, F., "A Study on Organisational Gossip and Workplace Loneliness at Public Entreprises", *International Journal of Management Economics and Business*, International Conference of Management Economics and Business (ICMEB'17) Special Issue, 106-119, 2017.

[20] Çankır, B., Semiz Çelik, D., "Operating Performance and Financial Performance: Positive Sound Removal, Reliable Good-Creating and Working Relationship Between Comfort and Hotel Operations", *Istanbul Gelisim University Journal of Social Sciences (IGUJSS)*, 5(2), 54-67, 2018. Doi: http://dx.doi.org/10.17336/igusbd.387588

[21] Tekin, E., "The Effects of Leader-Member Exchange on Employee Performance: The Mediating Role of Organizational Citizenship Behavior", *Karadeniz Technical University Institute of Social Sciences Journal of Social Sciences*, 8(16), 343-363, 2018.

[22] İnce, A.R., Tosun, N., "A Research on the Determination of Components of Internal Customer Oriented Corporate Reputation and Evaluation of Its Effects on Employee Performance", *The Journal of KAU IIBF*, 6(11), 37-52, 2015.

[23] Tutar, H., Altınöz, M., "The Effect of Organizational Climate on Employee Performance: A Study on the Employees of Ostim Manufacturing Enterprises", *Ankara University Journal of the Faculty of Political Science (Ankara University SBF Journal)*, 65(2), 195-218, 2010.

[24] Rotundo, M., Sackett, P.R., "The Relative Importance of Task, Citizenship, and Counterproductive Performance to Global Ratings of Job Performance: A Policy-Capturing Approach", *Journal of Applied Psychology*, 87(1), 66-80, 2002. Doi: 10.1037//0021-9010.87.1.66

[25] Çekmecelioğlu, H.G., "The Effects of Task-Oriented Leadership and People-Oriented Leadership Styles on Organizational Commitment, Job Performance and Intention to Leave", *Kocaeli University Journal of Social Sciences (KOSBED)*, 28, 21-34, 2014.

[26] Borman, W.C., Motowidlo, S.J., "Task Performance and Contextual Performance: The Meaning for Personnel Selection Research", *Human Performance*, 10(2), 99-109, 1997.

[27] Yorulmaz, M., "The Relationships Between Seafarers' Job Satisfaction, Task, and Contextual Performance", *Journal of ETA Maritime Science (JEMS)*, 6(4), 349-363, 2018. Doi: 10.5505/jems.2018.20981

[28] Karakoç, A. "Effects of Job Satisfaction on Organizational Commitment and Job Performance: An Application on Insurance Agent Workers", Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences, 23(4), 1371-1388, 2018.

[29] Türkoğlu, T., Yurdakul, Ü., "The Investigation of the Relationship Between the Job Satisfaction and Job Performance of Employees in Furniture Sector", *Artvin Coruh University Journal of Forestry Faculty,* 18(1), 88-97, 2017.

[30] Nasab, A.H., Afshari, L., "Authentic Leadership and Employee Performance: Mediating Role of Organizational Commitment", *Leadership & Organization Development Journal,* 40(5), 548-560, 2019. Doi:10.1108/LODJ-01-2019-0026

[31] Çelik, M., Çıra, A., "The Mediating Role of Work Overload on the Effects of Organizational Citizenship Behavior on Job Performance and Turnover Intention", *Ege Academic Review,* 13(1), 11-20, 2013.

[32] Işık, M., Kama, A., "The Mediating Role of Work Engagement on the Impact of Perceived Organizational Support on Employee Performance", Anemon Journal of Social Sciences of Mus Alparslan University, 6(3), 395-403, 2018. http://dx.doi.org/10.18506/anemon.338253

[33] Nazir, O., Islam, J.U., "Enhancing Organizational Commitment and Employee Performance through Employee Engagement: An Empirical Check", *South Asian Journal of Business Studies,* 6(1), 98-114, 2017. Doi:10.1108/SAJBS-04-2016-0036

[34] Begenirbaş, M., Turgut, E., "The Effects of Trust Perception and Employee's Emotional Labor In An Organization For Acquiring Job Performance", *"Is Guc" Industrial Relations and Human Resources Journal,* 16(3), 131-149, 2014. Doi: 10.4026/1303-2860.2014.0259.x

[35] Ali, A., Bin, L.Z., Piang, H.J., Ali, Z., "The Impact of Motivation on the Employee Performance and Job Satisfaction in IT Park (Software House) Sector of Peshawar, Pakistan", *International Journal of Academic Research in Business and Social Sciences,* 6(9), 297-310, 2016. Doi: 10.6007/IJARBSS/v6-i9/2311

[36] Bıyık, Y., Şimşek, T., Erden, P., "Ethical Leadership's Effect on the Employees' Job Performance and Job Satisfaction", *Gazi Journal of Economics and Business,* 3(1), 59-70, 2017.

[37] Uysal, H.T., Yıldız, M.S., "Effect of Work Psychology on the Organizational Cynicism for Employee Performance", *The Journal of International Social Research,* 7(29), 835-849, 2014.

[38] Arslan, M., Roudaki, J., "Examining the Role of Employee Engagement in the Relationship Between Organisational Cynicism and Employee Performance", *International Journal of Sociology and Social Policy,* 39(1/2), 118-137, 2019. Doi: 10.1108/IJSSP-06-2018-0087

[39] Erdirençelebi, M., Yazgan, A.E., "Mobbing, Organizational Cynism, Organizational Commitment and Their Effects on Determined Working Performance", *Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences,* 22(2), 267-284, 2017.

[40] Çöl, G., "The Effects of Perceived Empowerment on Employee Performance", *Dogus University Journal,* 9(1), 35-46, 2008.

[41] İraz, R., Akgün, Ö., "A Study on the Effects of the Organizational Commitment to the Performance of Employee", *Journal of Selçuk University Social Sciences Vocational School,* 14(1-2), 225-250, 2011.

[42] Sekaran, U., *Research Methods For Business: A Skill-Building Approach,* John Wiley & Sons, New York, 1992.

[43] Tayfun, A., Çatır, O., "Research About the Relation between Organizational Silence and the Performance of Workers", *Journal of Business Research-Türk,* 5(3), 114-134, 2013.

[44] Amarat, M., Akbolat, M., Ünal, Ö., Güneş Karakaya, B., "The Mediating Role of Work Alienation in the Effect of Workplace Loneliness on Nurses' Performance", *Journal of Nursing Management,* 27(3), 553-559, 2019. Doi: 10.1111/jonm.12710

[45] Saygılı, M., Erigüç, G., Özer, Ö., "Determining Organizational Silence and Employee Performance Levels of Healthcare Professionals", *The Journal of Academic Social Science Studies*, 49, 485-500, 2016. http://dx.doi.org/10.9761/JASSS3625

[46] Şantaş, F., Şantaş, G., Özer, Ö., Güleç, M.B. "A Research on the Relationship between Organizational Cronyism and Employee Performance in Health Employees", *Eskişehir Osmangazi University Journal of Economics and Administrative Sciences*, 13(3), 37-54, 2018.

[47] Tekingündüz, S., Kurtuldu, A., Eğilmez, Ç., "The Analysis of the Effects of Social Support, Job Alienation and Job Stress on Labour Performance", *International Journal of Human Sciences*, 13(1), 683-694, 2016. doi:10.14687/ijhs.v13i1.3512

[48] Akbolat, M., Ünal, Ö., Amarat, M., Güneş Karakaya, B., "İş Yerinde Yalnızlaşmanın İş Performansına Etkisi", *Proceedings of International Balkan and Near Eastern Social Sciences Congress Series (IBANESS), Tekirdağ/Turkey,* Ed. DK Dimitrov, D Nikoloski, R Yılmaz, Volume II,, 24-29, 2018.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.07

IJHSRP

Research Article

IMMUNOHISTOCHEMICAL ANALYSIS OF SFLT-1 AND ADAMTS-8 EXPRESSION IN DIABETIC RAT TESTIS TISSUE

Seval Kaya*[1], Yusuf Nergiz[1], Fırat Asır[1], Ebru Gokalp-Ozkorkmaz[1], Gamze Erdogan[1], Engin Deveci[1]

[1]Dicle University, Faculty of Medicine, Department of Histology& Embryology, Diyarbakır, Turkey.
* Corresponding author: seval.kaya@hotmail.com

Abstract*: The aim of this study was to determine the testicular inflammation and angiogenetic effect of diabetes with ADAMTS-8 and SFlt-1 proteins immunohistochemically. Wistar albino male rats (n: 12) were used for the study, Group 1: Control group (n: 6), only 1 ml i.p. saline injection was performed. Group 2: Diabetes group (n: 6) received a single intraperitoneal dose of streptozotocin (STZ) of 60 mg/kg. The glucose value measured above 250 mg/dl was considered as diabetic. Under anesthesia, dissection was performed at the lower part of abdominal clearance and testicular tissue was removed. Testis tissues were fixed in 10% neutral formalin, followed by the routine paraffin protocol and cut with a microtome. Then, primary antibodies (ADAMTS-8, sFlt-1) were applied by the immunohistochemistry method and incubated at +4 ˚C overnight. The sections were then examined under a light microscope. The diabetes group showed that Leydig cells in the intertubular area had vacuolization and capillary dilatations in histopathological examinations. sFlt-1 staining of the control group showed positive expression in capillary endothelium between Leydig chambers of the intertubular area. Sflt-1 expression of diabetes group was observed in degenerative spermatic cells and Sertoli cells of the basement membrane facing tubules. The expression of the ADAMTS-8in control group was positive in some Leydig cells in the interstitial area of Sertoli cells in seminiferous tubule but, spermatogenetic cells were negative. In the ADAMTS-8 staining of the diabetes group, the expression of ADAMTS-8 was increased in the stromal cells and some inflammatory cells in the intertubular space. SFlt-1 plays a crucial role in angiogenesis as well as in diabetic testes and is marked as a precursor for the disruption of vascular structure and blood flow due to degenerative changes. It is thought that the distribution of ADAMTS-8 may be a determinant protein in the development of the extracellular matrix and in damage to testicular tissue of diabetic testis.***

Keywords*: Diabetes, testis, ADAMTS-8, sFlt-1, immunohistochemistry*

Received: November 25, 2019 Accepted: December 9, 2019

1. Introduction

Diabetes mellitus (DM) is a common metabolic disease characterized by increased blood sugar in the long term.DM causes complications in various organs of the retina, heart and reproductive system in both sexes of humans and animals [1]. Patients with diabetes diagnosed with libido, impotence and

fertility impairments in sexual function including declines emerge [2]. Diabetes also disrupts spermatogenesis and reduces sperm count, sperm motility, seminal fluid volume, and testosterone levels [3-5]. Diabetes oxidative stress and damage to cell components it is known to cause an increase in free radical production [6-7].

ADAMTSs, a disintegrin and thrombospondin motif metalloproteinase, is found in the M12B (adamalysin) subgroup [8]. ADAMTS-8 has cell adhesion, cell fusion, proteolysis and signal transduction functions [9]. This protease has been shown to separate proteoglycans such as aggrecan, versican and brevican [10]. The substrate aggregate ADAMTS-8 is expressed in macrophage-rich regions in atherosclerosis [11]. ADAMTS-8 has been reported to inhibit VEGF-mediated angiogenesis in vitro endothelial cells [12].

The association of diabetes with different types of ADAMTS families was investigated and it was reported that ADAMTS-4 and ADAMTS-5 increased in diabetes but decreased with insulin therapy [13].

Soluble Fms-Like Tyrosine kinase-1 (sFlt-1), also known as Vascular Endothelial Growth Factor Receptor-1, is an endothelial receptor for PlGF and VEGF [14] and is a tyrosine kinase protein with anti-angiogenic properties [15].

The aim of this study was to demonstrate the testicular inflammation and angiogenetic effect of diabetes as a result of ADAMTS-8 and sFlt-1 proteins immunohistochemically.

2. Material and Methods

2.1. Experimental Animals

Our study was approved by Dicle University Health Sciences Research Center Local Ethics Committee.12 Wistar albino male rats weighing 200-250 gr were taken from Dicle University Experimental Animals Unit. Group 1: Control group (n: 6), 1 ml i.p. the saline injection was performed. Group 2: Diabetes group (n: 6), streptozotocin (STZ) with a single dose intraperitoneally (60 mg/kg) was prepared in 0.1 M pH: 4.5 citrate buffer and i.p. diabetes was induced by injections (STZ, Sigma Aldrich, USA).72 hours after STZ injection, glucose was measured as diabetic with a drop of blood taken from the tail vein of the rats using a glucometer. Rats were anesthetized by intraperitoneal injection of 5 mg/kg xylazine HCl and 40 mg/kg ketamine HCl. Dissection of the lower abdomen was performed to remove testicular tissue.

2.2. Histopathological procedure

Testicular tissues were fixed with 10% neutral formalin. Routine paraffin tissue follow-up protocol was applied.4-6 μm sections were obtained from paraffin blocks. It was then incubated in xylene for 2x30 minutes and the sections were brought to distilled water. Some of the sections were stained with routine Hematoxylin and Eosin, the remainder were incubated for 3x5 minutes in PBS for immunostaining.

2.3. Immunohistochemical procedure

Following the routine paraffin protocol, 4-6 μm paraffin sections were cut with a microtome (Leica, Germany) Antigen release was carried out twice (5 min and 3 min) in citrate buffer solution (pH: 6.0) in a 700 W microwave oven. The sections were allowed to cool for 20 minutes at room temperature

and washed twice with distilled water for 4 minutes. The endogenous peroxidase blockade was performed in a 10% hydrogen peroxide solution for 7 minutes. The washed samples were incubated in Ultra V block (catalog no. TA-015UB, Thermo Fischer, USA) for 8 minutes. Blocking solution was removed from the sections and allowed to incubate overnight at +4 ° C with primary antibodies (ADAMTS-8 PA5-64274, Thermofischer, USA), sFlt-1 (ab9540, Abcam).After washing the sections in PBS, the secondary antibody (TP-015-BN, ThermoFischer, USA) was applied for 20 min. The sections were washed in PBS for 2x5 min and then exposed to streptavidin-peroxidase (TS-015-HR, ThermoFischer, USA) for 20 min. Sections washed with PBS were allowed to react with DAB (TA-001-HCX, ThermoFischer, USA) chromogen. Counterstaining with hematoxylin was applied and after washing, the preparations were closed. Sections were examined under a light microscope (Carl Zeiss Imager A2, Germany).

3. Results

Table 1. Glucose values of control and diabetes mellitus groups

	Control (n=6)	**Diabetes (n=6)**	*p
Glucose (mg/dL) ± SD	95,22±5,34	402,12± 28,72	<0.001
Values are given as mean ± SD.			

Glucose values of the control and diabetes groups were compared (Table 1). Blood glucose concentration was significantly increased in diabetic rats ($p < 0.001$).

3.1. Histopathological results

The control group, the basement membrane of the seminiferous tubules was of normal thickness and the sperm cells were placed in the tubule towards the surface regularly and the apical were normal in appearance. Leydig cells in the inter-tubular area showed solitary and regular localization around the blood vessels in groups (Figure 1).

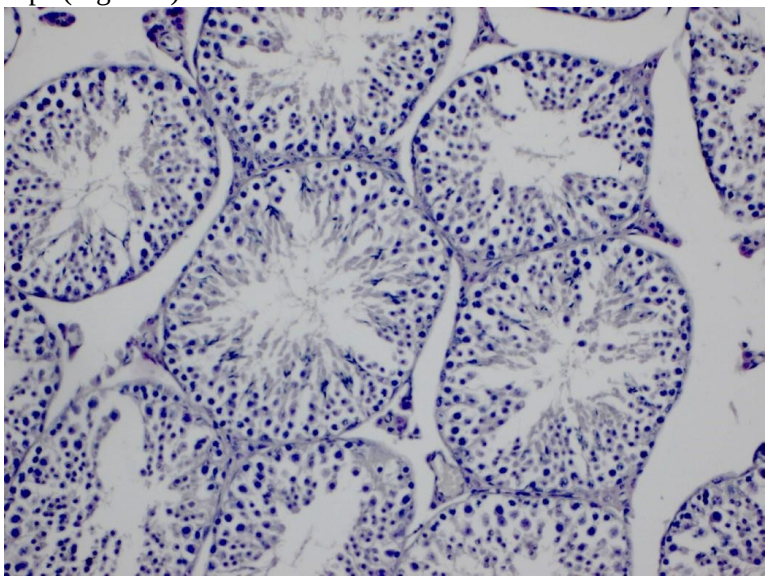


Figure 1. Control group testis section normal view. Hematoxylin & Eosin Bar: 50µm

Diabetic group, thickening of the basement membrane, degeneration of spermatic cells, pyknosis and loss of nuclei of cells towards the surface, deterioration of spermatid formation and degenerative change of sertoli cells were observed. The occurrence of vacuolization and capillary dilatations were observed in Leydig cells in the intertubular area (Figure 2).

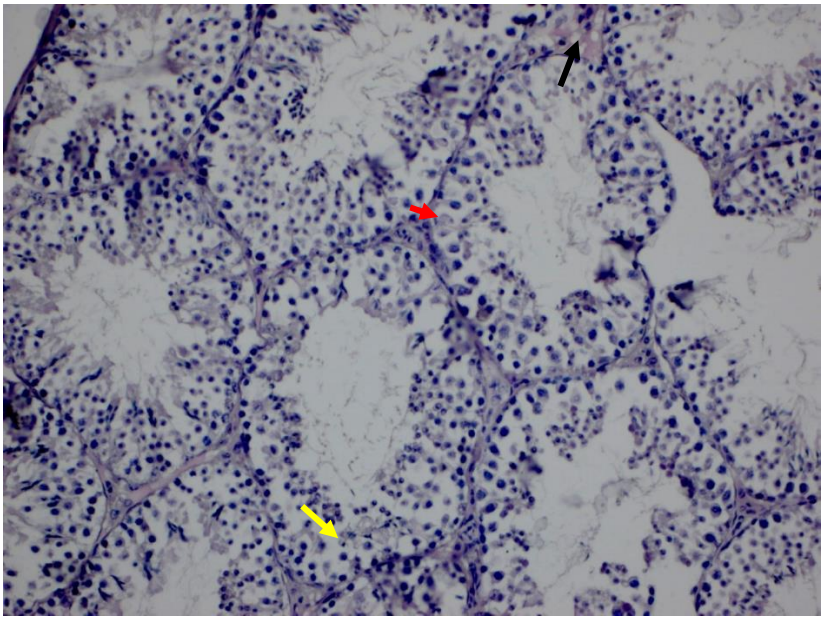


Figure 2. Diabetes group testis section. pyknosis (yellow arrow), sertoli cell (red arrow), vacuolization (black arrow). Hematoxylin & Eosin Bar: 50µm

3.2. Immunohistochemical results

The ADAMTS-8 control group showed positive outward ADAMTS-8 expression in the seminiferous tubular basement membrane, while the expression of ADAMTS-8 was positive in some Leydig cells in the interstitial space in the Sertoli cells in the tubule, while the spermatogenetic cells were negative (Figure 3).

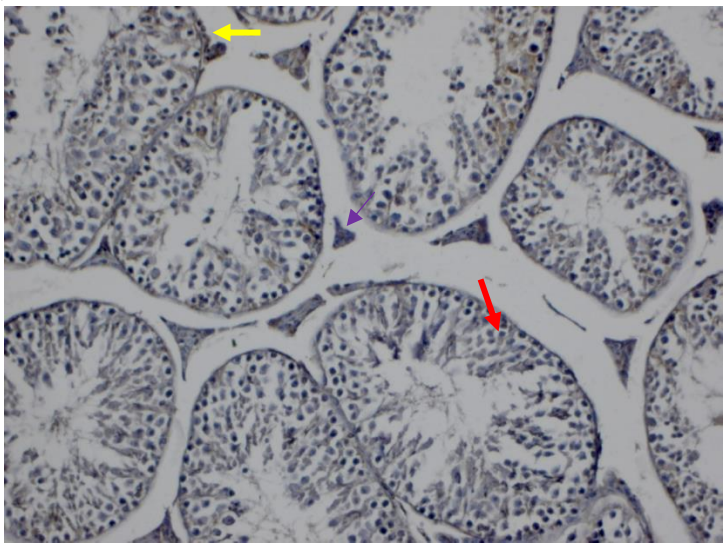


Figure 3. Testis section of the ADAMTS-8 control group. Outwardly, ADAMTS-8 expression was positive (yellow arrow) in the seminiferous tubular basement membrane, ADAMTS-8 expression was positive (purple arrow) in Leydig cells, and spermatogenetic cells were negative (red arrow). Immuno-staining. Bar: 50µm

The ADAMTS-8 diabetes group showed increased ADAMTS-8 expression in the membrane outside the tubules, but increased expression of ADAMTS-8 in stromal cells and some inflammatory cells in the interstitial space. Spermatids located in the apical side of some sertoli cells in the tubule also showed ADAMTS-8 positive reaction (Figure 4).

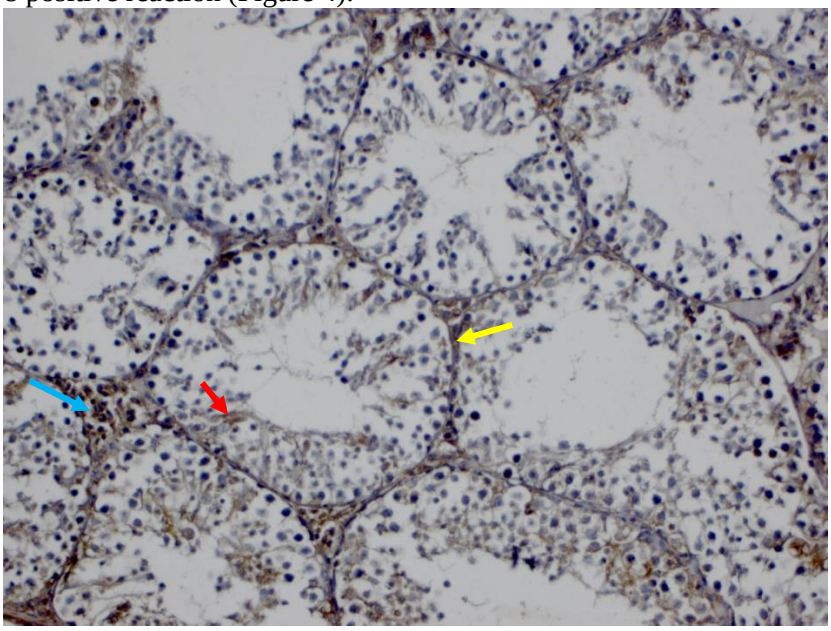


Figure 4. Testicular section of ADAMTS-8 diabetes group, increased ADAMTS-8 expression in the membrane (yellow arrow), ADAMTS-8 expression in stromal cells and some inflammatory cells (blue arrow), ADAMTS-8 positive reaction in spermatids (red arrow). Immuno-staining. Bar: 50µm

SFlt-1 control group, sFlt-1 positive reaction was observed in some spermatids whose negative sFlt-1 expression did not mature towards the surface in the majority of spermatic cells in Seminiferous tubules. Capillary endothelium sFlt-1 showed positive expression among Leydig cells in the intertubular area (Figure 5)

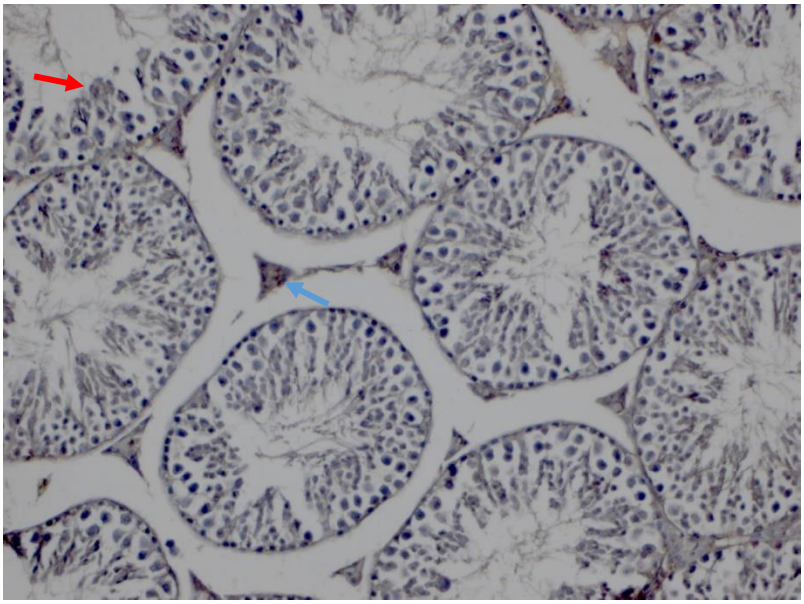


Figure 5. Testis section of the SFlt-1 control group, immature spermatids (red arrow), capillary endothelium (blue arrow). SFlt-1 immunostaining Bar: 50µm

In the SFlt-1 diabetes group, the expression of sFlt-1 was positive in the degenerative spermatic cells and sertoli cells on the tubular side of the basement membrane. In addition, sFlt-1 reaction was evaluated as positive in immature spermatids and sperm (Figure 6).

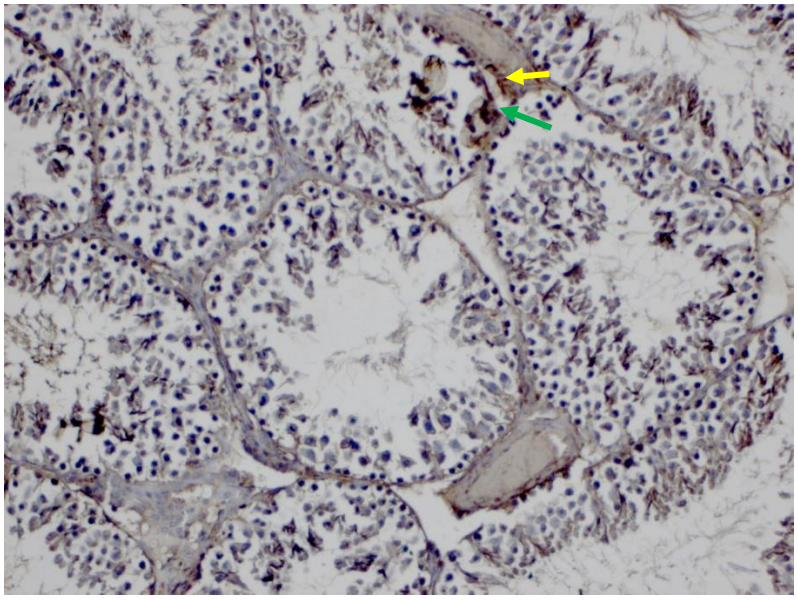


Figure 6. Cross-section of the testis of the SFlt-1 diabetes group, degenerative spermatic cell (green arrow), dilated blood vessels endothelial cell (yellow arrow). Immuno-staining Bar: 50µm

4. Discussion

Diabetes is known to cause decreased androgen receptors in rats, impaired hormone synthesis and sexual function, as well as abnormalities such as sperm count, motility and quality, as well as decreased testicular weight [16].

The ADAMTS family is an important protein in angiogenesis that is found in the connective tissue as aggregates and versicans. Versican is a protein that leads to remodeling of the vascular structure. ADAMTS-8 protein has an angiogenetic inhibitory effect in the structure of the extracellular matrix in the regulation of various cancers that have the ability to suppress tumor genes in tumor proliferation [17].

ADAMTS-8 is a large molecule that carries an enzyme that binds to lipoproteins from proteoglycans in the extracellular matrix to versican cytokines. It has been reported that ADAMTS-8 protein may be under the influence of extracellular matrix damage due to diabetes and changes in the basement membrane structure [18].

Although ADAMTS-8 expression was increased in our study, ADAMTS-8 expression was increased in stromal cells and some inflammatory cells in the intertubular space. It is thought that the inflammation process may increase with cytokine activity due to alteration of the vertical molecule structure in ADAMTS-8.

The soluble VEGF receptor, SFlt-1 protein, has been reported to cause dysfunction of endothelial cells and decreased angiogenesis in patients with renal insufficiency [19].

Irtegün and Deveci in their study, VEGF expression in the testicular tissues of the DM group is almost undetectable compared to the control group, the decrease in VEGF expression as a result of the decrease in the endothelial permeability and may lead to insufficient angiogenesis may occur. [20].

It was seen that sFlt-1 effect was similar to VEGF reaction in diabetic endothelial cell dysfunction and sFlt-1 expression was increased in endothelial cells of dilated blood vessels in interstitial space in SFlt-1 treated group.

5. Conclusion

Due to diabetes damage, degenerative changes in the spermatic cells of the testis with Sertoli cells induce apoptosis-induced inflammation between the tubules and increased vascular dilatation has been observed. It is thought that steroid secretion changes in Leydig cells and testosterone secretion are adversely affected by increasing vacuolar structure.

SFlt-1 plays an important role in the regulation of angiogenesis, and it has been shown to lead to the deterioration of the vascular structure and blood flow due to degenerative changes in diabetic testes. ADAMTS-8 distribution is thought to be a determinant protein in the development of extracellular matrix in diabetic testis and testicular injury due to inflammation.

References

[1] Rowley WR, Bezold C, et al., ‘‘Diabetes 2030: insights from yesterday, today, and future trends’’, Popul Health Manag, 20(1), 6–12, 2017.

[2] Feng SL, Li S H, et al., ‘‘Effect of ligustrum fruit extract on reproduction in experimental diabetic rats’’, Asian J Androl, 3, 71–73, 2001.

[3] Guneli E, Tugyan K, et al., ‘‘Effect of melatonin on testicular damage in streptozotocin-induced diabetes rats’’, Eur Surg Res, 40(4), 354–360, 2008.

[4] Oksanen A., ‘‘Testicular lesions of streptozotocin diabetic rats’’, Horm Res, 6(3), 138–144, 1975.

[5] Sexton WJ, Jarow JP., ‘‘Effect of diabetes mellitus upon male reproductive function’’, Urology, 49(4), 508–513, 1997.

[6] Po K., ‘’Streptozotocin-induced diabetes increases apoptosis through JNK phosphorylation and Bax activation in rat testes’’, J Vet Med Sci, 69(9), 969-71. 2007.

[7] Alves MG, Martins AD, et al., ‘’Molecular mechanisms beyond glucose transport in diabetes-related male in fertility’’, Biochim Biophys Acta, 1832(5), 626-35, 2013.

[8] Rawlings ND, Tolle DP, Barrett AJ., ‘’MEROPS: the peptidase database’’, Nucleic Acids Res, 32, 160–4 2004.

[9] Porter S, Ian M, et al., ‘’The ADAMTS metalloproteinases’’, Biochem J, 386, 15–27, 2005.

[10] Yamaji N, Nishimura K, et al., ‘’Novel metalloprotease having aggrecanase activity’’, Yamanouchi Pharmaceutical, Japan, 2001.

[11] Wagsater D, Bjork H, et al., ‘‘ADAMTS-4 and 8 are inflammatory regulated enzymes expressed in macrophage-rich areas of human at hero sclerotic plaques’’, Atherosclerosis, 196(5), 14-22, 2008.

[12] Vazquez F, Hastings G, et al., ‘’METH 1, a human ortholog of ADAMTS-1, and METH-2 are members of a new family of proteins with angio-inhibitory activity’’, J Biol Chem, 274(233), 49-57, 1999.

[13] Dincel CG, Yildirim S., ‘‘Overexpression of ADAMTS-13 and neuronal nitric oxide synthase relates with neuropathology in streptozotocin-induced type 1 diabetic’’, Int J Clin Exp Pathol, 9(4), 4761-4778, 2016.

[14] Shibuya, M., et al., ‘‘Nucleotide sequence and expression of a novel human receptor-type tyrosine kinase gene (flt) closely related to the fms family’’, Oncogene, 5(4), 519-24. 1990.

[15] Farina A, Eklund E, et al., ‘‘First-trimester biomarker panel for predicting the development of gestational diabetes’’, Reprod Sci, 24(6), 954-959, 2017.

[16] Lin SH, Wang ZS., ‘‘Study on the expression of androgen receptor in testis, epididymis and prostate of adult rats with diabetes’’, Zhonghua Nan Ke Xue 11(4), 891, 2005.

[17] Kılıç ÖM, Aynekin B, et al., ‘‘Differentially regulated ADAMTS1, 8, 9, and 18 in pancreas adenocarcinoma’’, Prz Gastroenterol, 12 (4), 262–270, 2017.

[18] Zhao C, Zya Y, et al., ‘‘The quantification of ADAMTS4 and 8 expression and selection of reference genes for quantitative real-time PCR analysis in myocardial infarction’’, Biomed Pharmacother, 65(8), 555-9, 2011.

[19] Di Marco SG, Reuter S, et al., ‘‘The Soluble VEGF Receptor sFlt1 Contributes to Endothelial Dysfunction in CKD’’, J Am Soc Nephrol, 20(10), 2235-2245, 2009.

[20] Irtegun S, Deveci E., ‘‘Examining the Expression Level of VEGF and Bcl-2 By Immunohistochemistry and Western Blot in Testis Tissue of Diabetic Rats’’, J Med Dicle, 43(4), 527-533, 2016.

INESEG
INTERNATIONAL ENGINEERING SCIENCE AND EDUCATION GROUP

International Journal of Health Services Research and Policy
www.dergipark.org.tr/ijhsrp

e-ISSN: 2602-3482 DOI:10.23884/ijhsrp.2019.4.3.08

IJHSRP

Research Article

SUSTAINABILITY, EQUITY AND EFFECTIVENESS IN PUBLIC FINANCING FOR HEALTH IN UGANDA: AN ASSESSMENT OF MATERNAL AND CHILD HEALTH SERVICES

***Vincent Okungu**[1,2], **Marshal Mweu**[1], **Janine Mans**[3]

[1]School of Public Health, University of Nairobi; [2]Philips East Africa
[1]School of Public Health, University of Nairobi
[3]Nathan Associates, Inc.
*Corresponding author: okungu008@gmail.com

Abstract: *This assessment aimed to understand whether financing for maternal, child health and immunization services are sustainable, efficient, effective and equitable. Data sources included various national and international reports related to financing maternal and child health services. The results show that funding for maternal and child health (MCH) services are unsustainable over the long term because the main financing source is out-of-pocket (67% of the total for MCH). However, Uganda shows higher efficiency in delivery as it has the lowest average cost per delivery (USD 50) compared to USD 70 (Kenya) and USD 95 (Ghana). Overall, MCH interventions being financed show some levels of effectiveness; e.g. maternal mortality rates dropped from 420/100000 live births in 2010 to 343/100000 live births in 2016; under-5 mortality rates reduced from 151/1000 live births in 2000 to 64/1000 live births in 2016. There are, however, inequities by region, age, education status and wealth index; e.g. 37% in the poorest quintile have unmet family planning needs compared to only 23% in the wealthiest quintile. In conclusion, public financing for primary services such as MCH requires reforms to strengthen health sector performance. The reforms should address sustainable financing, efficiency, effectiveness, and equity in service delivery.*

Keywords: *Maternal Child Health, Public Finance, Uganda*

Received: June11, 2019 Accepted: October 6, 2019

1. Introduction

Uganda's population is estimated at about 40 million people as of 2017 and growing at more than 3% per annum[1]. The high annual growth rate is attributed to the high total fertility rate of over six children per woman observed for the last four decades against the backdrop of declining mortality rates. By 2020, women within the reproductive age bracket (15-49 years of age) will constitute about 20% of Uganda's total population and an equal proportion is children below the age of five years[2].
Currently, Uganda has the highest proportion of young people in the world, with more than half (57%) of Uganda's population under the age of 18 years. The population trends and structure result in high demand for maternal and child health services including immunization; efforts should focus on ensuring that the demand for these services is equitably met at all levels nationwide.

The ongoing transformation of the Ugandan health sector is meant to improve access to quality services for all with a focus on primary health care. However, the groundwork for the transformation of the health sector has not been effectively financed; e.g., recent rapid growth in government expenditure

between FY 2012/13 and FY 2016/17 has not benefited the health sector proportionally. Overall, the health sector received only 6% of the total share compared to other sectors such as Works and Transport (21%), Education (13%) and Justice, Law and Order (10%)[3]. The health sector has not been given the priority it deserves even with the evidence of the growing burden of communicable and non-communicable diseases (NCDs).

Specifically, the global burden of disease (2016) shows that maternal and neonatal health conditions contribute about 22 percent of years of life lost (YLL) in Uganda[4]. To address the public health burden resulting from maternal and child health conditions, the MOH has defined strategic policy goals to achieve the longer-term Sustainable Development Goal (SDG) targets by 2030. The highlights of the strategic policy goals include addressing the main causes of maternal deaths; ending preventable newborn and under-5 mortalities through improvement of immunization coverage and timely access to health care; improving adolescent health by making efforts to control teenage pregnancies, child marriages and scaling up contraceptive use, and working toward universal health coverage (UHC). To support this ambitious agenda, Uganda is planning to establish a National Health Insurance Scheme and promote voucher programs to increase demand-side financing for the use of family planning and safe motherhood services by the poor[5]. Also, the Uganda National Expanded Program on Immunization (UNEPI) supports routine immunization services to accelerate the control or elimination of vaccine-preventable diseases, surveillance and outbreak response, and introduction of new vaccines. Current efforts under the Comprehensive EPI Multi-Year Plan (cMYP) 2016- 2020 aims to sustain gains on DPT immunization, introduce new vaccines, and strengthen microplanning and implementation of the Reach Every District/Reach Every Child (RED/REC) strategy in all districts, as well as improving overall program management of EPI at all levels[6]. The national immunization coordination committee (NICC) is expected to play a critical role in ensuring the success of immunization programs. The country has achieved significant increases in numbers of children immunized with a reported 6.6% increase in total immunization between 2014 and 2018[7].

The political will to improve immunization coverage and safeguard child survival is evident when in 2016 Parliament passed the Immunization Act, which provides for compulsory immunization of children, women of reproductive age and other target groups against vaccine-preventable diseases. Uganda is yet to reach the immunization coverage target of 80% of the target populations but has partnered with the Global Alliance for Vaccines and Immunization (GAVI) and other development partners to introduce new vaccines, such as the pneumococcal conjugate vaccine (PCV) and the human papillomavirus (HPV), as part of the strategy to reach immunization targets. Going forward, GOU is working to introduce the new rotavirus vaccine, the yellow fever vaccine, the MenA vaccine, and the inactivated polio vaccine (IPV).

Overall, Uganda has made little progress toward improving the health of mothers and children; the country still ranks among the top 10 countries in the world with high maternal, newborn and child mortality rates[8]. The country has poor reproductive, maternal, neonatal, child and adolescent health (RMNCAH) indicators. Neonatal mortality rate (NMR) has remained stagnant for the last decade though maternal mortality rate (MMR) and child mortality trends show important reductions. About 20% of Ugandans live below the poverty line as of 2013[1, 9] and this could be a contributing factor toward the relatively poor MCH indicators. The Health Sector Development Plan (HSDP) 2015/16 – 2019/20, prioritizes improvements in MCH indicators and recognizes among other factors, poor policy implementation as the main contributor to the high mortalities. The Sharpened Plan (2016 – 2020), a

component of the HSDP, specifies the strategies to be used to accelerate progress towards improving MCH indicators. The plan focuses on strengthening the national health service delivery system and prioritization of a package of technical interventions and strategies that will realize the largest health impact for the country based on the latest evidence on effectiveness[5]. Part of the plan to The multi-faceted approach to immunization in Uganda is an example of a plan to improve service delivery systems. The Mother and Child Survival Program (MCSP), the Stronger Systems for Routine Immunization (SS4RI), the Uganda Muslim Medical Bureau (UMMB) and the Ministry of Health through the Expanded Program on Immunization (UNEPI), are among the key players that are involved in the expansion of immunization coverage to reach every child with immunization services that are effective, safe, responsive to community needs and are sustainable. MCSP, in particular, has introduced the Reach Every Child (REC)- QI approach as part of its global innovations and learning agenda to improve immunization coverage and effectiveness [10]. With a focus on public financing, the study aimed to assess whether Uganda's financing for maternal and child health services is sustainable, efficient, effective and equitable.

2. Methods

This study derives its information in two main ways. First, as part of a public expenditure review (PER) for Uganda's Ministry of Health, conducted with funding from USAID, we looked at various national and international documents related to financing health care generally and specifically financing for maternal and child health services, and immunization. Second, we analyzed documents containing indicators for maternal and child health services and immunization and assessed their correlations with financing trends in terms of sustainability, efficiency, equity, and effectiveness. The exercise took place from December 2017 to June 2018. Data search and collection was largely targeted, i.e. we specifically sought online and hard-copy documents on MCH and immunization financing and indicators from the Ministry of Health (MOH)- Uganda, the Uganda Bureau of Statistics (UBOS) and organizations such as the World Health Organization (WHO), the World Bank and GAVI. Uganda's health management information system (HMIS) also provided considerable data to inform our analysis.

Key government documents considered in the analysis included the National Development Plan (I & II), various national health accounts (NHAs), national demographic health surveys (DHS), among other reports specific to MCH and immunization. These plus other technical reports and documents were obtained both directly from MOH counterparts and indirectly through online sources. A few additional documents were retrieved through Google search, which included regional and global reports as well as peer-reviewed journal articles specific to MCH and immunization in Uganda. A combination of search terms used included "maternal health financing Uganda"; "maternal child health budget Uganda)"; "maternal child health indicators Uganda"; and maternal mortality Uganda".

The analysis was mainly descriptive and involved looking at trends in budgetary allocations and financing of maternal and child health programs as well as immunization, and making correlations and inferences concerning sustainability, efficiency, effectiveness, and equity. Findings were peer-reviewed by senior officials from the Ministry of Health (MOH), officers from the United States Agency for International Development (USAID) and the World Bank.

Ethical approval

Secondary data sources were used in the article so no ethical approval was required.

3. Results

3.1. Financing trend and sustainability

There is an upward trend in maternal and child health (MCH) financing in Uganda. For MCH, the proportion of spending increased from FY 2012/13 to FY 2015/16[11, 12]. Overall, MCH services received 16.2% of government funds for health programs, trailing only HIV/AIDS (21.9%) and oral health conditions under NCDs (17.2%), and exceeding malaria (11.9%). However, in terms of total health spending on MCH issues, households (private sources) bear the greatest burden because the majority of the funds is paid out-of-pocket (Table 1).

Table 1. Spending on Maternal and child health, average FY2015/16)

	Private		**Public**		**Development Partners**		**Total**
	USD Millions	**%**	**USD Millions**	**%**	**USD Millions**	**%**	**USD Millions**
Maternal conditions	67.77	66.52	19.60	19.24	14.52	14.25	101.89
Perinatal conditions	48.40	77.76	8.08	12.97	5.77	9.27	62.25
Family planning	0.001	0.01	3.11	19.51	12.82	80.48	15.92
Other reproductive health (n.e.c.)	0.001	0.01	4.54	46.70	5.18	53.29	9.72
TOTAL	**140.16**	**67%**	**35.32**	**17%**	**32.82**	**16%**	**208.30**

Financing health care primarily through out-of-pocket is highly inequitable as the cost burden is borne by individual households. However, the immunization program in Uganda is largely donor-driven with reports from GAVI [13] indicating that external resources accounted for about 81% of total funding.

3.2. Efficiency

While unit costs are not available across the full range of MCH services, analysis of facility-level data on the costs of delivery demonstrates a wide variety of costs. Overall, Uganda is one of the countries in sub-Saharan Africa with a relatively lower average cost of delivery (Figure 1)[14]. The average cost of birth varies greatly by the type of health facility. This difference may be due to a range of issues; e.g., hospitals may tend to attract more complicated births due to higher caliber staff and equipment, leading to higher average costs. There may be also lessons that can be learned on more routine deliveries, e.g., those related to the greater reliance on midwives in health facilities tend to have lower costs.

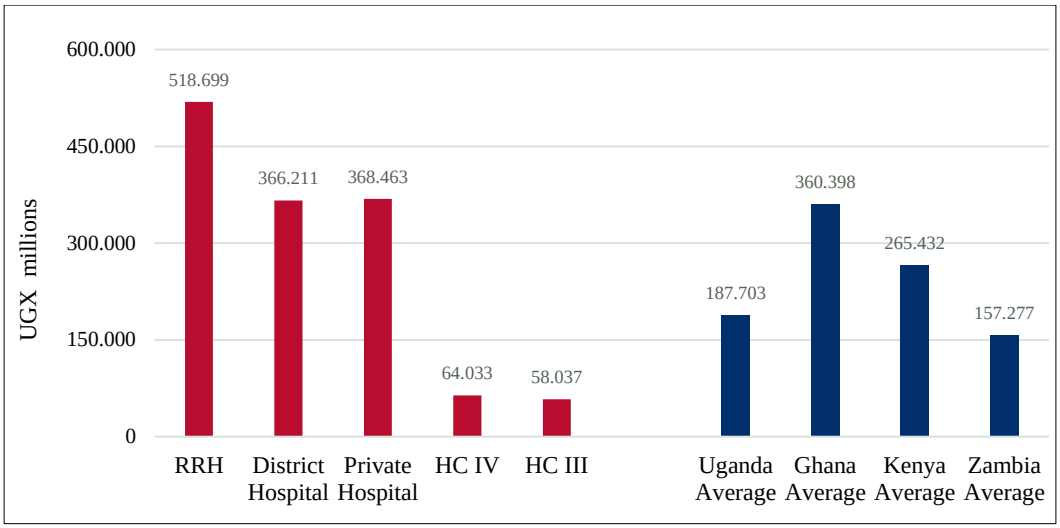


Figure 1. The average cost of delivery - by facility type and across comparator countries (UGX)
Note: All data is for 2011 except Zambia, which is for 2010

Health provider costs as shown reflect different mixes of staff and medications and other material, as well as different staffing patterns. The two mission health facilities had higher material costs than the two public health facilities, while the public hospital has higher personnel costs for four of the six services. In contrast, the mission health center had higher labor costs than the public health center for all three services the center provided. Reflecting differences in utilization levels in relation to staffing, midwives at the mission hospital delivered more babies per year on average (68 deliveries per year) than at the public hospital (39 per year). Public health center midwives delivered the most babies per year (116 per year per midwife) followed by private midwives (108 per year). Most international standards suggest that a nurse midwife could perform 15 to 20 births per month, or 180 to 240 births per year, though an additional midwife would be needed in a facility setting to cover for leave time and women needing services at the same time[15].

The costing analysis estimated the additional costs in 2016 - 2020 of increasing access to the MCH priority packages in Uganda to be US$ 274 million, including systems investments. While costs vary depending on packages and delivery levels, estimates show that the average additional per capita investments per year are US$ 0.70, US$ 4.69, and US$ 1.69 for the core, expanded and comprehensive packages respectively.

3.3. Effectiveness

Recent data show improvements in maternal and child mortality rates which suggests that MCH interventions have been relatively effective even if not at the levels expected (Figure 2).

Figure 2a. Maternal deaths per 100,000 live births

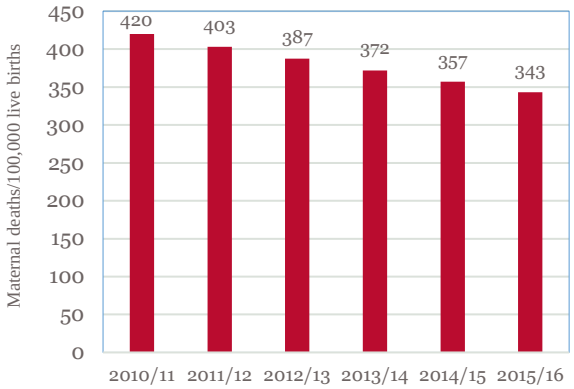


Figure 2b. Reductions in child mortality (deaths per 1,000 live births)

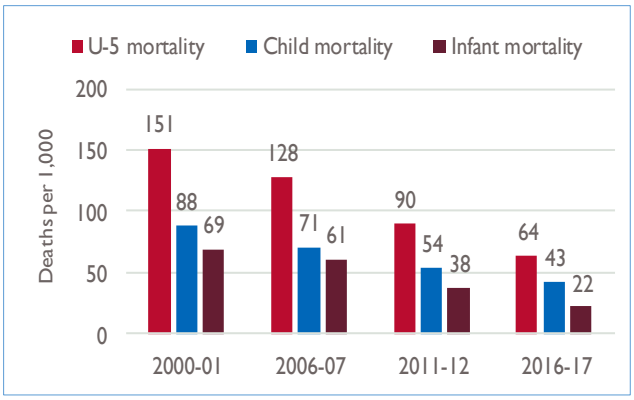


Figure 2. Maternal and child health in Uganda

As Figure 2 shows, there are significant improvements in under-5 (U-5) and child mortality rates; however, maternal mortality per 100,000 live births has remained stubbornly high even though there were some improvements in the period 2010 to 2016. More strategic interventions including increased financing for maternal and child health services from a prepaid pool of funds are required to rapidly lower MMR in Uganda to reach SDG targets.

Further scrutiny suggests that the full impact of maternal and child health interventions may be limited due to the lack of appropriate equipment and materials at the facility level. The 2012 ABCE survey [14] found that only 13% of the facilities in the sample reported having the full stock of medications, tests, and medical equipment recommended for the provision of ANC. Less than five percent of health centers (HCs) were fully equipped to provide ANC. For deliveries, less than 10% of all facilities were fully equipped for routine deliveries, and many lower-level facilities do not offer emergency obstetric services (Figure 3).

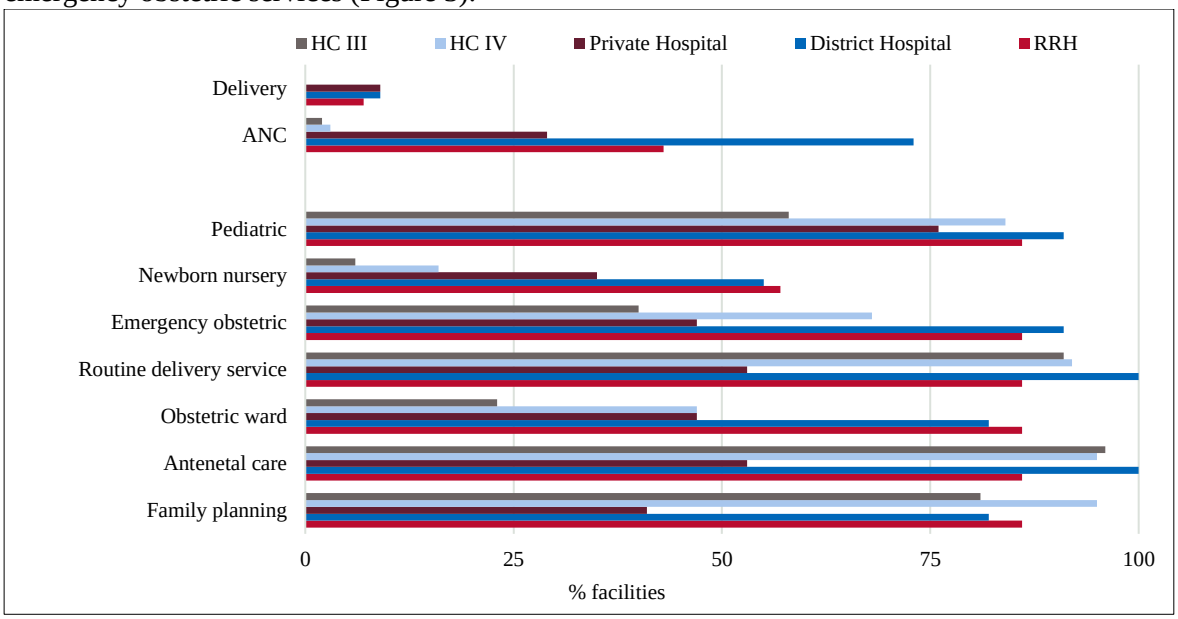


Figure 3. Availability of facilities and equipment for maternal and child health services

On the other hand, the expansion of vaccine coverage has a clear relationship with funding levels (Figure 4). The increase in funding in 2013/14 had a clear impact on increased immunization coverage in the following year and the dip in funding in FY2014/15 appears to have yielded a lower average coverage rate the following year. This indicates that overall spending appears to be well-targeted. A key challenge in immunization seems to be in maintaining a linear progression in coverage (Figures 4), which could be partially linked to inconsistency in financing.

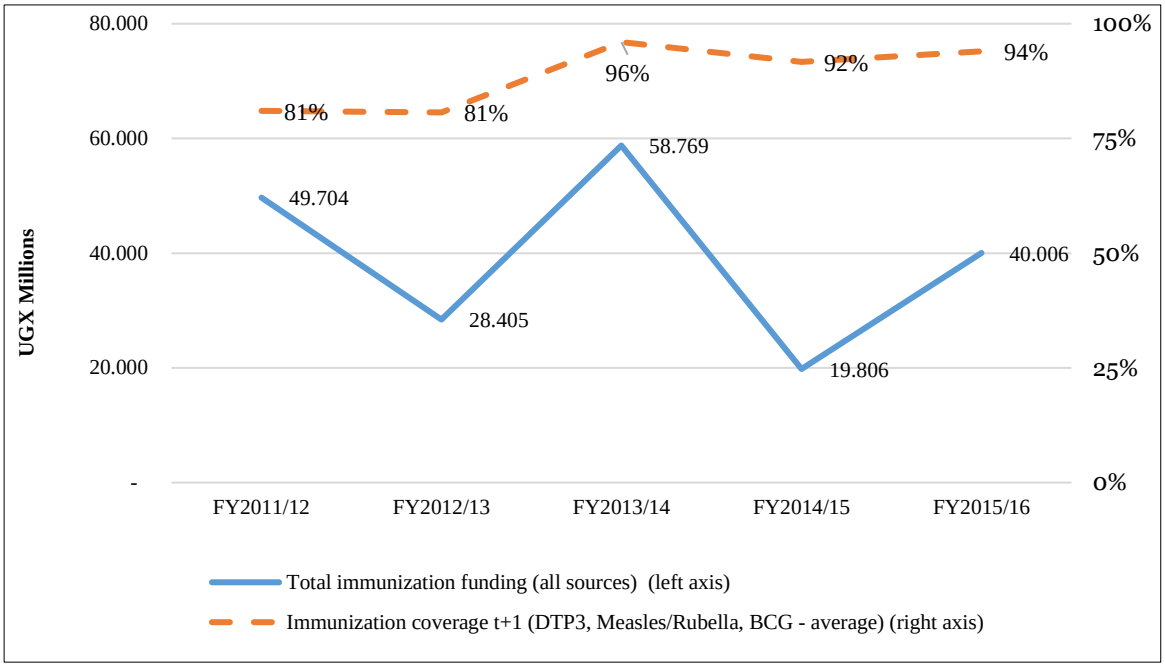


Figure 4. Trends in immunization spending and vaccine coverage (year t+1)
Source: National Health Accounts (NHA) 2011/12. 2013/14, 2015/16; World Health Organization (WHO) Country reported immunization data

3.4. Equity

Indicators for both maternal and child health programs and immunization interventions register levels of inequity. For example, although maternal and child health indicators have been improving steadily in Uganda, there is unequal distribution in these improvements by location and wealth status. Rural areas, for example, report poorer maternal health service use indicators than urban areas, which could be linked to various dimensions of access to maternal health services including affordability[16]. The DHS 2015/16 data indicate that the gap in access appears to be largest with respect to skilled deliveries and/or at a health facility[17] (Figure 5).

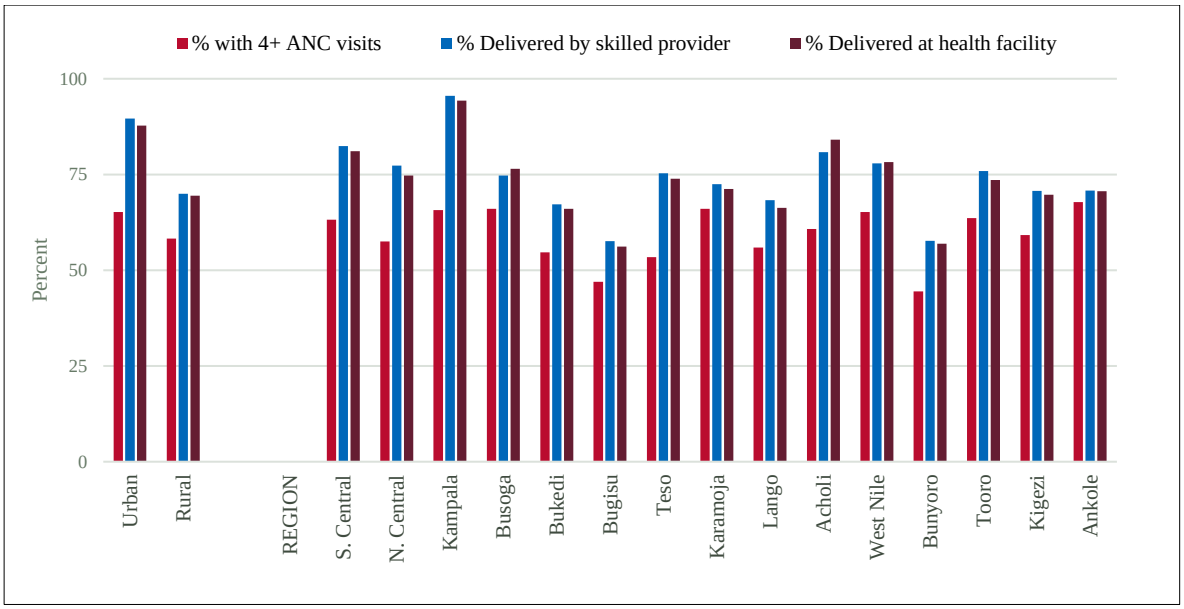


Figure 5. Percent of women who had a live birth in the 5 years preceding Demographic Health Survey (DHS) 2016 survey using maternal health services

Regionally, the Bugisu and Bunyoro perform below 60% in all maternal health indicators even though they are not the poorest regions, suggesting other factors apart from poverty have a role in the existing inequities in maternal health outcomes. Inequities also exist between the rich and poor; e.g. about 66% of women in the highest quartile who had a live birth attended all four ANC visits compared to 54% of women from the poorest quartile. Also, about 93% of the wealthiest households had a delivery at a health facility compared to 64% of the poorest quartile. There are also marked differences in unmet family planning needs by all parameters (Figure 6). Unmet family planning needs have implications on maternal health outcomes and child survival. Rural area residents have higher unmet needs than their urban counterparts indicating poorer maternal and child health outcomes in rural than urban areas. Overall, the poorest households reported unmet FP needs at 37% compared to about 22% in the richest households. This disparity is not evenly felt, however. Karamoja has the lowest unmet needs (about 20%) even though it is one of the poorest regions in Uganda, while West Nile (43%) and Busoga (about 37%) have the highest unmet needs.

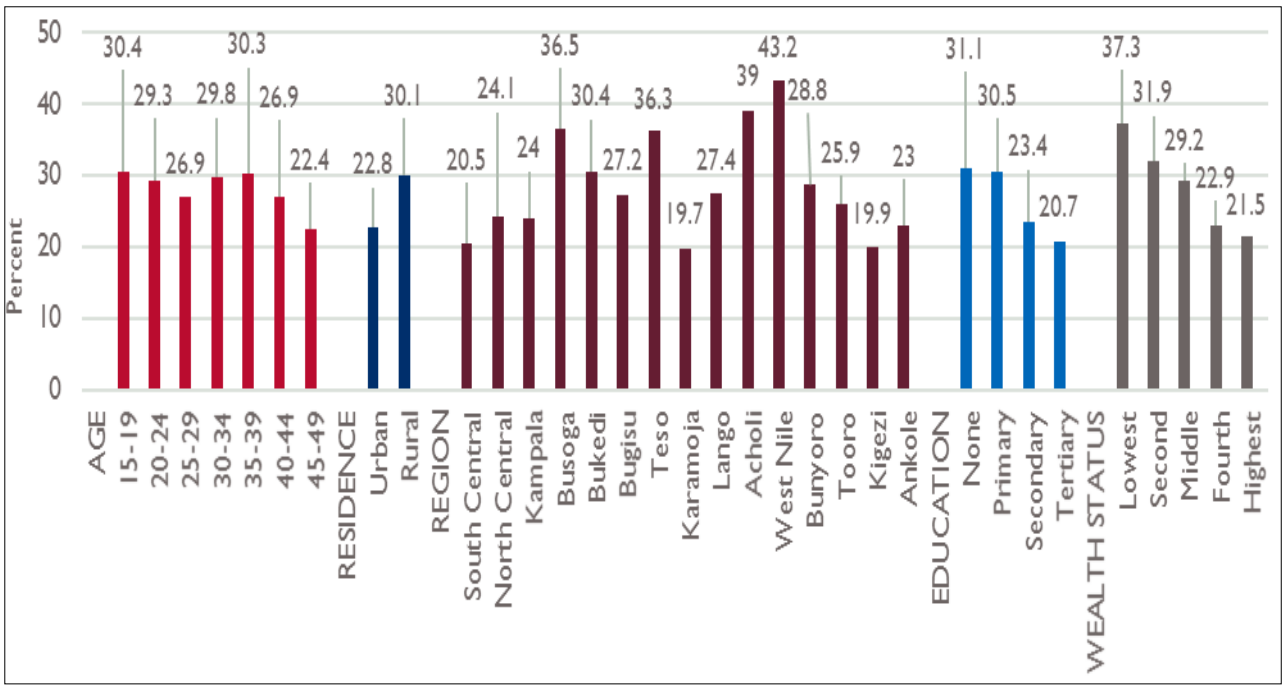


Figure 6. Percent of population with unmet family planning needs by category
Source: Demographic and Health Survey (DHS) 2015/16

Inequities are also evident in vaccine coverage. Vaccination is a key ingredient in child health but differences in coverage are reported in terms of gender, residence (rural vs. urban), regions and level of education. There has been progressing in filling these equity gaps which could be linked to various factors including better targeting as well as the focus on rural and hard to reach populations, e.g. in Karamoja. The fact that vaccines are fully subsidized therefore poses no financial barriers to access is another important factor. The best performing region in terms of overall vaccine coverage is Karamoja which is one of the poorest regions in Uganda. High vaccine coverage in the poorest region (Karamoja) as well as the fact that coverage is highest in the poorest quintile for basic (56%) and all-age appropriate vaccinations (41%) and lowest in the wealthiest quintile (54% and 40.9%) respectively (Figure 7), suggests there is no direct link between wealth status and vaccine coverage in Uganda. However, wide variations in coverage still exist regionally and in levels of education which deserve the attention of policymakers.

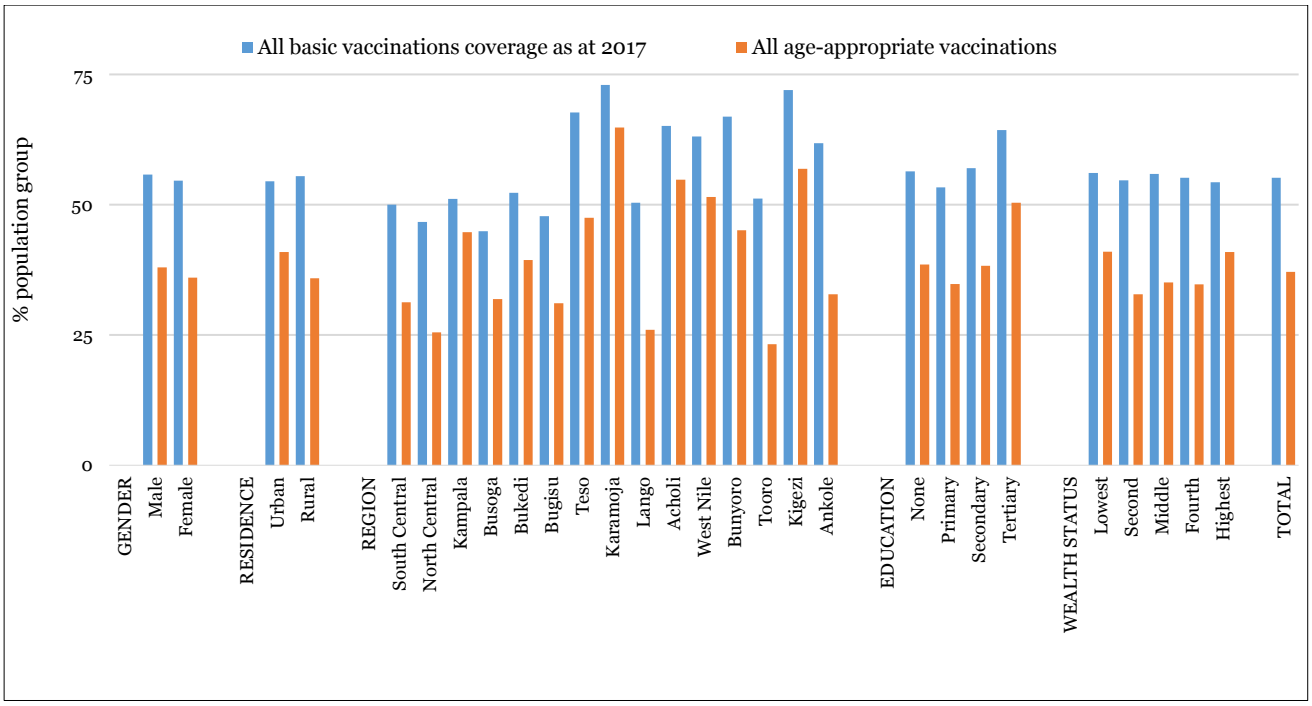


Figure 7. Vaccine coverage by gender, region, education and wealth quintile (percent)

Maternal and child health outcomes are not entirely encouraging but more coordinated efforts from all stakeholders including financing agents and policymakers are required to register rapid progress in MCH outcomes.

4. Discussion

Initiatives to improve MCH services in Uganda in the past decade have been spearheaded largely by the national Safe Motherhood Program (SMP). The initiatives involve developing networks of traditional birth attendants (TBAs) and interventions to forecast high-risk obstetric events and strengthen referral systems[18]. Despite these and other efforts, Uganda remains one of ten countries globally which contribute the highest maternal, new-born and child mortality rate[2, 5, 18]. The contradiction between the intervention and outcome could be linked partially to the fact that the SMP focused its attention on TBAs even though Uganda has a large shortfall of health workers especially of midwives to deliver a range of life-saving interventions[18]. The government has for several years now frozen recruitment of health workers due to fiscal constraints, which, unfortunately, is a common fiscal practice across the East African region.

The primary focus for Uganda currently is developing a prepaid health system and moving away from reliance on out-of-pocket (OOP) payments to pursue universal health coverage (UHC). The global report on public health expenditure indicates rising domestic sources of funding for health in low- and middle-income countries (LMIC) [19]. As a long-term strategy to address fiscal shortfalls and achieve UHC, there is consensus on the need for LMIC to pursue innovative health financing models, improve efficiency in the use of existing resources and increase and sustain domestic financing for health care to reduce donor dependency and OOP payments[20, 21]. Currently, financing for MCH relies largely on OOP payments and donor funding respectively. Existing evidence[22-27] indicates that these types of financing arrangements are both inefficient and unsustainable. OOP payments, in particular, represent

the worst form of fragmentation; they place the financing burden on individuals and are impoverishing. On the other hand, donor funds are often unpredictable and a lot of its inflow depends on external factors beyond the control of the recipient country. In short, in terms of financing MCH services including immunization in Uganda, a lot still remains to be done to promote sustainability and ensure that interventions are more effective than they are currently. Hence the motivation to be innovative in financing health care to raise more revenue, contain rising health care costs, reduce OOP payments and compensate for the dwindling external funding.

Domestic financing is particularly critical in consolidating the gains already made in reducing maternal and child mortality. Currently, financing, especially from the government, is both inadequate and inconsistent for MCH services. Increasing funding from public sources is fundamental and driven by, first, the need to adequately equip all health facilities for at least routine deliveries, and second, the need to implement the recommendations of the Immunization Program Financial Sustainability Plan. However, an increase in funding should be complemented by the efficient use of all available resources. Hence, the government is encouraged to identify and roll-out good practice by health facilities demonstrating a lower cost per dose of delivering vaccines for example, while maintaining delivery models that are appropriate to the demographic group being targeted. Also, continued use of pooled procurement mechanisms for MCH supplies including vaccines will achieve economies of scale in procurement. Where efficient, there is a need to implement strategies to reduce wastage.

Critical efficiency gains will specifically be realized by expanding the use of cost-efficient service delivery options – such as the use of mid-wives for a routine delivery. Establishing bEmONC ready and accessible facilities at the sub-county level will increase access to quality skilled birth attendance especially for the poor majority. Service delivery improvements at the lower levels will yield returns in terms of system performance at HC IV and hospital levels by reducing patient loads and assisting referral. On the other hand, equipping HC IV and General Hospitals for cEmONC will only make a significant difference if other investments such as effective emergency transport to these facilities and financial or other impediments to their attendance are addressed. Addressing access issues in high burdened urban districts such as Kampala and Wakiso requires providing financial support to the poorest urban families through voucher schemes. This would allow eligible families to access the private sector for quality MCH services without investing in public sector infrastructure. Of utmost importance is addressing the obvious systemic inefficiencies current in Uganda[28-31]; there is often no guarantee that donor funds for MCH services do end up in these services due to fungibility in aid[32, 33].

Cultural, geographic and socio-demographic factors seem to be the main drivers of inequity in MCH services including immunization coverage. There is a clear relationship between maternal and child mortality as well as immunization coverage on the number of antenatal care visits, maternal education, age, area and region of residence[34]. On the whole, the combination of poor financing and a host of socio-demographic factors have clearly contributed to below per outcomes in MCH. For example, in 2016, 41% of all pregnancies in Uganda were unintended and about 25% of women in Uganda have had their first child by age 18[34]. These suggest relative ineffectiveness of ongoing maternal health interventions as evidenced by high unmet family planning needs as well as unacceptably high maternal mortality rates. As a signatory to the Global Strategy for Women's and Children's Health, Uganda failed in all its efforts around millennium development goals (MDGs) 4 and 5As of 2011 and, given the current progress rate, shows no signs of achieving the health-related sustainable development goal (SDG) 3 by 2030.

In conclusion, Uganda has registered some progress in improving maternal and child outcomes. However, progress remains unacceptably slow such that Uganda remains one of the highest-burden countries globally in terms of maternal health outcomes. The country needs to pull together in addressing maternal and child mortalities by first of all re-prioritizing the health sector in government expenditure and improving the allocation of funds to MCH and immunization services. Policy reforms to expand domestic resources for health should consider key areas such as efficiency, effectiveness, and equity in service delivery. To address the reported inequities, for example, root-cause analysis of socio-demographic and regional differences in uptake of maternal health and immunization services should be considered. The current focus of MCH efforts in rural areas is commendable but Uganda's urban population is rapidly increasing- depicting a five-fold increase in the last three decades and are increasingly becoming highly burdened. These are factors that should be considered in the design of effective MCH interventions.

Acknowledgment

Funding for the project was from USAID and implemented by Nathan Associates, Inc. We thank the following for their participation in the management of the project and data collection: Mr. Enock Mwami, Mr. John Kauta, and Mr. Joseph McGrann.

References

[1] Government of Uganda, "State of Uganda Population Report 2018: Good Governance- A prerequisite to harness the Demographic Dividend for Sustainable Development " Government of Uganda, Kampala, 2018.

[2] Uganda Bureau of Statistics, "Uganda Demographic and Health Survey," Government of Uganda, Kampala, 2016.

[3] Uganda Bureau of Statistics, "Statistical abstract," Uganda Bureau of Statistics, Kampala2017.

[4] Global Burden of Collaborative Disease Network, "Global Burden of Disease Study 2016 (GBD 2016) Results," Institute for Health Metrics and Evaluation (IHME), Seattle. Available: http://ghdx.healthdata.org/gbd-results-tool2017.

[5] Ministry of Health, "Family Planning 2020 Commitment," Kampala. Available: http://www.familyplanning2020.org/entities/802017.

[6] Ministry of Health, "Comprehensive EPI Multi-Year Plan (2016- 2020)," Government of Uganda, Kampala, 2016.

[7] Ministry of Health, "Annual Health Sector Performance Report," Government of Uganda2018.

[8] Save the Children, "State of the World's Mothers Report 2015," Save the Children, London, United Kingdom, 2015.

[9] World Bank. Uganda Poverty Assessment: 2016: Fact Sheet [Online].

[10] MCS Program, "Uganda country summary," Available: https://www.mcsprogram.org/wp-content/uploads/2017/04/Uganda-Country-Summary-March-2017.pdf2017.

[11] Ministry of Health, "National Health Accounts: Financial Years 2012/13 & 2013/14," Government of Uganda, Kampala, 2015.

[12] Ministry of Health, "National Health Accounts 2015/16," Government of Uganda, Kampala2017.

[13] GAVI, "Gavi Full Country Evaluations: 2016 Dissemination Report," IHME, Seattle, WA2017.

[14] IHME, "Assessing Facility Capacity, Costs of Care, and Patient Perspectives," University of Washington, Seattle: Available: https://www.healthdata.org/sites/default/files/files/policy_report/2014/ABCE/Uganda/ABCE_Uganda_full_report_2014.pdf2014.

[15] T. Dmytraczenko, M. McEuen, and A. Levin, "Costs of Maternal Health Care Services in Masaka District, Uganda. Special Initiatives Report 16," USAID, Washington DC, 1999.

[16] S. Nam, "Final Evaluation of the Figo Saving Mothers and Newborns Project in Uganda," Options. Available: https://www.figo.org/sites/default/files/uploads/project-publications/SMN/Uganda_3.pdf 2011.

[17] Uganda Bureau of Statistics and ICF, "Uganda Demographic and Health Survey 2016: Key Indicators Report," Uganda Bureau of Statistics (UBOS) and ICF, Kampala, Uganda and Rockville, Maryland, USA, 2017.

[18] The Partnership for Maternal Newborn & Child Health, "Maternal and Child Health: Uganda," Available: https://www.who.int/pmnch/media/membernews/2011/ugandabackgroundpaper.pdf2012.

[19] K. Xu, A. Soucat, J. Kutzin, C. Brindley, N. V. Maele, H. Touré, et al., "Public Spending on Health: A Closer Look at Global Trends," World Health Organization, Geneva(WHO/HIS/HGF/HFWorkingPaper/18.3). License: CC BY-NC-SA 3.0 IGO, 2018.

[20] WHO, "Sustainable health financing, universal coverage and social health insurance. World Health Assembly Resolution WHA58.33," World Health Organization, Geneva, 2005.

[21] WHO, "Domestic resource mobilization for sustainable financing for health in Africa African Region. Working Paper prepared by the WHO Regional Office for Africa," World Health Organization, Geneva, 2017.

[22] K. Xu, D. B. Evans, G. Carrin, and A. M. Aguilar-Rivera, "Designing health financing systems to reduce catastrophic health expenditure," World Health Organization, Geneva, 2005.

[23] K. Xu, D. B. Evans, K. Kawabata, R. Zeramdini, J. Klavus, and C. J. Murray, "Household catastrophic health expenditure: a multicountry analysis," *Lancet*, vol. 362, no. 9378, pp. 111-7, Jul 12, 2003.

[24] W. Van Damme, L. Van Leemput, I. Por, W. Hardeman, and B. Meessen, "Out-of-pocket health expenditure and debt in poor households: evidence from Cambodia," *Trop Med Int Health*, vol. 9, no. 2, pp. 273-80, Feb 2004.

[25] A. Leive and K. Xu, "Coping with out-of-pocket health payments: empirical evidence from 15 African countries," *Bull World Health Organ*, vol. 86, no. 11, pp. 849-856, Nov 2008.

[26] O. Galarraga, S. G. Sosa-Rubi, A. Salinas-Rodriguez, and S. Sesma-Vazquez, "Health insurance for the poor: impact on catastrophic and out-of-pocket health expenditures in Mexico," *Eur J Health Econ*, vol. 11, no. 5, pp. 437-47, Oct 2010.

[27] T. Bright, L. Felix, H. Kuper, and S. Polack, "A systematic review of strategies to increase access to health services among children in low and middle-income countries," *BMC Health Serv Res*, vol. 17, no. 1, p. 252, Apr 5, 2017.

[28] W. B. Asea, "Combating political and bureaucratic corruption in Uganda: Colossal challenges for the church and the citizens," *HTS Teologiese Studies/Theological Studies*, vol. 74, no. 2, 2018.

[29] R. Flanary and W. David, "The state of corruption: A case study of Uganda," *Third World Quarterly,* vol. 20, no. 3, pp. 515-536, 1999.

[30] J. M. Kewaza, "Fighting corruption in Uganda: Despite small gains, citizens pessimistic about their role," Afrobarometer Dispatch2016, vol. No. 77 Available: http://afrobarometer.org/sites/default/files/publications/Dispatches/ab_r6_dispatchno77_uganda_corruption.pdf.

[31] M. Martini, "Uganda: Overview of corruption and anti-corruption," Transparency International, Available: https://knowledgehub.transparency.org/assets/uploads/helpdesk/379_Uganda_Overview_of_corruption_and_anticorruption.pdf2013.

[32] S. Leiderer, "Fungibility and the Choice of Aid Modalities: The Red Herring Revisited," United Nations University, Helsinki2012, vol. Working Paper No. 2012/68 Available: https://www.wider.unu.edu/sites/default/files/wp2012-068.pdf.

[33] S. Devarajan and V. Swaroop, "The Implications of Foreign Aid Fungibility for Development Assistance," Development Research Group, World Bank, Washington, DC, 1998.

[34] R. Atuhaire and W. Kaberuka, "Factors Contributing to Maternal Mortality in Uganda," *African Journal of Economic Review,* vol. IV, no. 2, pp. 43 - 57, 2016.