



Prevalence and Unit Cost of Abnormalities Detected in Abdominal Sonography among Soldiers

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Received May 22nd, 2022

Accepted June 21st, 2022

Published July 21st, 2022

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ABSTRACT

Introduction: According to military doctrine, soldiers must maintain their health in order to remain strong and healthy at all times. Furthermore, they must be physically fitter than those in other professions.

Objective: To determine the prevalence of detected abnormalities and the unit cost of clinically significant abnormalities discovered during health screening by abdominal ultrasound (US) in soldiers. Study the prevalence of detected abnormalities and the unit cost of clinically significant abnormalities from health screening by abdominal ultrasound (US) among soldiers.

Methods: This was a retrospective study of 841 male and female soldiers who underwent abdominal US health screening at Chulabhorn hospital between February and September 2020. Data collection included abnormalities detected by ultrasound and diagnostic results classified by clinical significance into three categories: abnormality with no clinical significance, abnormality requiring follow-up, and abnormality requiring treatment. The unit cost for those abnormalities is calculated using the list of diagnostic procedures. The most common abnormalities in the United States are fatty liver, liver nodules, gallbladder polyps, renal stones, solid and cystic renal lesions, and prostate gland enlargement.

Results: There were 841 soldiers, 502 males and 339 females, with an average age of 51.8 years. There were 1,043 lesions detected in 643 (76.4 percent) soldiers. Fatty liver affects 364 (43.3 percent) of patients, liver nodules affect 46 (5.5 percent), gallbladder polyps affect 90 (10.7 percent), renal stones affect 41 (4.9 percent), solid and cystic renal lesions affect 128 (15.2%), and prostate gland enlargement affects 113 (22.5 percent). There were 79 abnormalities that were classified as requiring treatment. The unit cost was 19,007 Baht.

Conclusion: The prevalence of abnormalities detected by abdominal US in this study is comparable to that reported in the literature for the general population. As a result, the expectation that soldiers will have fewer abnormalities detected on US soil may not be realized.

Keywords: *ultrasound abdomen soldiers; prevalence of abnormalities; cost for ultrasound*

Introduction

The Sonographer School is an educational institution to provide health screening or diagnostic services by ultrasound. During the year 2020, a group of soldiers underwent whole abdominal ultrasound (US)

for health screening. According to the doctrine and strategies of the Royal Thai Army Education Department, soldiers need to have higher physical fitness than those of other professions. They have to maintain their health in order to always be strong and

healthy. Exercise intervention has been shown to reduce non-alcoholic fatty liver disease which could be detected by US screening [1]. Regular exercise and weight control is also effective in preventing gallstone formation [2]. However, no studies have been ever conducted in soldiers for the prevalence of detected abnormalities by abdominal ultrasound. Whereas, there are many other health conditions or diseases that may be detectable by abdominal US among soldiers. In fact, the military service personnel receive welfare from the government for their costs of health screening.

Methodology

This was a descriptive and retrospective study in both male and female soldiers who underwent abdominal ultrasound between February 2020 and September 2020 at the Sonographer School, Chulabhorn Hospital. Data collection included gender, age, body mass index, congenital disease, and US results of upper and lower abdomen, as well as diagnostic information of abnormalities detected by US. The diagnostic information of abnormalities was analyzed and classified according to clinical significance and criteria as follows: 1) Fatty liver – mild, moderate, and severe following the bright liver score [3], 2) Liver nodule – benign and malignancies, 3) Gallstone – gallstone without complications and gall stone with complications (US finding cholecystitis due to gallstone) [2,4], 4) Gallbladder polyps – following the size criteria, such as 0-5 mm, 6-9 mm, ≥ 10 mm and in case of the combined gallstone and gallbladder polyps [5,6], 5) Renal stone – following the size criteria, such as < 5 mm and ≥ 5 mm [7], 6) Solid renal tumor – benign and malignancies, 7) Cystic renal mass – Bosniak classification [8], 8) Enlarged prostate (≥ 30 ml) – post voiding residual urine volume < 50 ml and ≥ 50 ml [9]. In addition, other abnormalities with or without clinical significance were also categorized into 3 groups as follows: Group 1 Abnormalities without clinical significance, such as mild fatty liver, gallbladder polyps size 0-5 mm, renal

cyst Bosniak I, II. Group 2 Abnormalities which require follow-up, such as moderate fatty liver, benign liver nodule, gallstone without complications, gallbladder polyps size 6-9 mm, renal stone size < 5 mm, benign solid renal tumor, renal cyst Bosniak I, IIF, enlarged prostate (post voiding residual urine volume < 50 ml). Group 3 Abnormalities require treatments, such as severe fatty liver, malignancies liver tumor, gallstone with complications, gallbladder polyps size ≥ 10 mm, gallbladder polyp with detected gallstone, renal stone size ≥ 5 mm, malignancies solid renal tumor, renal cysts Bosniak III, VI, enlarged prostate (post voiding residual urine volume ≥ 50 ml). When grouping patients according to clinical significance and more than one abnormality is detected in each individual case, the most clinically significant abnormality group was considered. Descriptive statistics was applied to report general information of the study population, number of patients, and abnormalities detected. For unit cost calculation, only the direct medical costs incurred from the US and additional diagnostic costs in case that the results of such detected abnormalities should be confirmed and charged to patients according to reference prices from the Comptroller General's Department. The detected abnormalities in each group were calculated from the total costs incurred by diagnostic process in the following formula:

$$\text{The unit cost} = \frac{\text{Total costs}}{\text{Number of detected abnormalities}}$$

Results

According to the general information of 841 soldiers who received abdominal US between February 2020 and September 2020, it showed that the mean age was 51.83 ± 7.96 years and the mean BMI was 25.02 ± 3.57 . High cholesterol was the most congenital disease in 206 soldiers, including others as shown in table 1.

Table 1 General information of patients

General information	Male	Female	Total
Number of patients	502 (59.7%)	339 (40.3%)	841 (100%)
Mean age (years) $\pm$ S.D.	54.25 $\pm$ 5.82	48.25 $\pm$ 9.24	51.83 $\pm$ 7.96
Mean Body Mass Index $\pm$ S.D.	25.51 $\pm$ 3.01	24.28 $\pm$ 4.12	25.02 $\pm$ 3.57
Number of high cholesterol	148 (29.5%)	58 (17.1%)	206 (24.5%)
Number of high blood pressure	86 (17.1%)	33 (9.7%)	119 (14.1%)
Number of diabetes	43 (8.5%)	17 (5.0%)	60 (7.1%)
Number of hepatitis B	2 (0.4%)	1 (0.3%)	3 (0.4%)
Number of thalassemia	0	1 (0.3%)	1 (0.1%)

The search results of the US report and diagnosis from abnormalities detected by the US yielded 643 patients (76.5%) including 404 males and 239 females. Whereas,

there were 198 patients (23.5%) with no detected abnormalities. The prevalence of detected abnormalities in soldiers was shown in table 2

Table 2 Prevalence of detected abnormalities in soldiers

Abnormalities	Number (percentage)		
	Male	Female	Total
Fatty liver	255 (50.8%)	109 (32.2%)	364 (43.3%)
Hepatic cysts	41 (8.2%)	34 (10.0%)	75 (8.9%)
Hemangioma or benign liver nodule	23 (4.6%)	22 (6.5%)	45 (5.4%)
Hepatocellular carcinoma	1 (0.2%)	0 (0.0%)	1 (0.1%)
Gallbladder polyps	65 (12.9%)	25 (7.4%)	90 (10.7%)
Gallstone	38 (7.6%)	34 (10.0%)	72 (8.6%)
Adenomyomatosis gallbladder	21 (4.2%)	17 (5.0%)	38 (4.5%)
Renal cysts	92 (18.3%)	26 (7.7%)	118 (14.0%)
Renal stone	26 (5.2%)	15 (4.4%)	41 (4.9%)
Angiomyolipoma	4 (0.8%)	6 (1.8%)	10 (1.2%)
Enlarged prostate gland	113 (22.5%)	0	113 (22.5%)*
Myoma uteri	0	74 (21.8%)	74 (21.8%)**
Abdominal aortic aneurysm	1 (0.2%)	0 (0.0%)	1 (0.1%)
Abdominal aortic atherosclerosis	1 (0.2%)	0 (0.0%)	1 (0.1%)

* Percentage per male patients only

** Percentage per female patients only

When studying details of each detected abnormality in patients with detected abnormalities and grouped according to clinical significance, the number of detected abnormalities with primary clinical significance and patients classified was in Group 3 or the group of abnormalities required for treatment for 79 lesions. Meanwhile, the number of 71 patients was classified into Group 3 required for treatment. Other detected abnormalities of secondary clinical significance and number of patients were shown in table 3.

According to the results of US, lesions requiring further diagnostic investigation included those found

nodules or a large mass in 16 subjects and lesions in the kidney including complicated cysts in 2 subjects and hyperechoic solid renal lesion in 1 subject. When classifying the list of diagnostics and price according to the Comptroller General's Department, the total costs were 1,501,600 baht as shown in table 4.

When calculating the unit cost of abnormalities categorized by clinical significance, it was found that the unit cost of abnormalities with no clinical significance or no required follow-up was 2,494 baht. The unit cost of abnormalities with required follow-up was 4,148 baht. The unit cost of abnormalities with required treatment was 19,007 baht as shown in table 5.

Table 3 Number of patients and number of detected abnormalities from abdominal US classified by clinical significance

Detected abnormalities classified by clinical significance	Number of patients (persons)/ Number of detected abnormalities (lesions)
Group 1 Detected abnormalities with no clinical significance or no required follow-up (Category I) Mild fatty liver, Hepatic cysts, Myoma uteri, Gallbladder Polyp size 0-5 mm, Adenomyomatosis gallbladder, Simple renal cysts, Abdominal aortic atherosclerosis	295 patients/ 602 lesions
Group 2 Detected abnormalities with required follow-up (Category II) Moderate fatty liver, Enlarged prostate gland (post voiding residual urine volume < 50 ml), Gallstones without complication, Hemangioma or benign liver nodule, Gallbladder Polyp size 6-9 mm., Renal stone size < 5 mm., Angiomyolipoma, Renal cysts (Bosniak IIF), Abdominal aortic aneurysm	277 patients/ 362 lesions
Group 3 Detected abnormalities with required treatment (Category III) Renal stone size ≥ 5 mm, Enlarged prostate (post voiding residual urine volume ≥ 50 ml), Severe Fatty liver, Gallbladder Polyp size ≥ 10 mm and Gallbladder polyp with gallstone detected, Gallstone with chronic cholecystitis, Hepatocellular carcinoma (HCC)	71 patients/ 79 lesions

Table 4 List and price of diagnostic radiology

List of diagnostic radiology	Price (baht)/ Time	Number of diagnostics (person/ time)	Total price (baht)
US upper abdomen	800	841	672,800
US lower abdomen	800	841	672,800
CT upper abdomen	6,000	5	30,000
CT whole abdomen	10,000	7	70,000
MRI upper abdomen	8,000	6	48,000
MRI liver	8,000	1	8,000
Total costs			1,501,600

Table 5 Unit cost of detected abnormalities classified by clinical significance

Abnormalities	Unit cost (baht)
Group 1 Detected abnormalities with no clinical significance or no required follow-up (Category I)	2,494
Group 2 Detected abnormalities with required follow-up (Category II)	4,148
Group 3 Detected abnormalities with required treatment (Category III)	19,007

Discussion

In this study, the prevalence of all abnormalities among soldiers showed that fatty liver was the most common abnormality, accounting for 43.3% and quite high when compared to other studies. For example, a study by Oshibuchi et al. examined the prevalence of abnormalities from upper and lower abdominal US in patients aged 20-60 years and fatty liver was noted in 15.52% [10]. Rungsinaporn and Phaisakamas studied the prevalence of abnormalities from upper abdominal US in patients aged 16-93 years and fatty liver was observed in 35.87% [11]. A study by Lee et al. on the prevalence of fatty liver disease among male soldiers, mean age 20.9 ± 1.3 years, showed fatty liver in 16.44% [12], with more attribution to the mean age of soldier group when compared to other studies in population with lower mean age or those with different age groups from teenagers to the elderly, which could be a factor for a higher prevalence of fatty liver disease. This was consistent with a study by Etminani et al. which yielded a greatest prevalence of fatty liver in those aged 50-60 years when compared to other age groups [13]. For abnormalities in liver mass, the most common was hemangioma 5.4%, consistent with another study with a prevalence of 0.4-20% as the most frequent non-cancerous liver lesion cases [14] and 1 case of hepatocellular carcinoma (0.1%). The prevalence was not significantly different from a study with liver cancer found by abdominal US in the general population. In a study by Rungsinaporn and Phaisakamas, the prevalence of liver cancer was reported for 0.2%, while no report of liver cancer in a study by Oshibuchi et al [10,11]. The prevalence of gallbladder abnormalities included gallbladder polyps and gallstones for 10.7% and 8.6%, respectively in this study. The prevalence of polyps and gallstones in the general population was quite different in each country or area of study. However, the results of this study were consistent with another study in populations of East Asian countries, such as China, South Korea, Japan, etc., with the prevalence of gallbladder polyps for 4.3-12.3% and gallstones for 2.0-10.7% [15,16]. The prevalence of renal abnormalities, including kidney stones, was 4.9% in this study, consistent with a study in populations of Asian countries for 1.0-5.0% [17]. Meanwhile, the prevalence of mass lesion abnormalities, including angiomyolipoma, in this study was 1.2%, consistent

with another study of 0.3-3.0%, as the most common non-cancerous renal anomaly [18]. Other abnormalities included non-cancerous cysts in the kidneys, of which most results showed normal cysts. The prevalence of abnormalities in the lower abdomen among male soldier group was 22.5% for an enlarged prostate from the abdominal US in a study by Lepor et al. reported prevalence of enlarged prostate gland about 20% in males population among 40 to 60 [19]. The mean age of males was 54.25 ± 5.82 years, this may result in higher prevalence of enlarged prostate, consistent with a study by Zhang et al. which stated a higher prevalence of enlarged prostate with increasing age [20]. The prevalence of abnormalities in the lower abdomen among female soldiers was only 21.8% for myoma uteri as benign abnormalities, consistent with a study by Dissaneevate which examined the effect of US in female subjects with no indications for US examination of the lower abdomen. [21]. Another significant abnormality in this study was abdominal aortic aneurysm (AAA), with a prevalence of 0.1% in a study by Dereziński et al. on the prevalence of AAA among rural and urban patients aged 60-65 years showed AAA in 0.82% and 1.01 in women group and men group, respectively [22]. The mean age of the population was 51.83 ± 7.96 years, this may result in a small number of patients who detected AAA in this study. From the results of this study, it was found that the prevalence and type of abnormalities among soldiers detected by abdominal US are comparable to other populations in the report literature. Therefore, the expectation that soldiers should have less abnormality detected in the US than the normal population may not be true. For the incurred costs in this study, the results showed that the unit cost of abnormalities requiring treatment was 19,007 baht, which was calculated from the total costs incurred from the diagnostic procedures according to the number of clinically significant abnormalities requiring treatment. Different costs incurred from the US were caused by additional diagnostic radiography to differentiate suspected cancerous lesions of the liver and kidneys. The diagnosis showed 1 liver cancer. The costs per cancerous abnormalities in this study was 1,501,600 baht. However, despite other non-cancerous abnormalities, they could result in patient morbidity if left untreated, including Renal stone size ≥ 5 mm with possible urinary obstruction [7], Enlarged prostate gland

in males with post voiding residual urine volume. ≥ 50 ml, as an indication of urinary retention in the bladder [9], Gallstone with chronic cholecystitis, Gallbladder polyp size ≥ 10 mm, and GB polyp with gallstone detected as potential early cancer [5,6]. In this study, it could not state if it was worthwhile in health economics. The study provided an overview of the costs of health screening among soldiers compared to the detected abnormalities as a basis for considering the guidelines for the welfare and list of health check-ups in a group of military service personnel.

Conclusion

The health screening by abdominal US in this study among soldiers yields abnormalities that require both treatment and follow-up which are not much different from other populations reported in the literature.

Competing Interests

None

Funding

None

Acknowledgements

Thanks to the Medical Records and Information Department, Chulabhorn Hospital for permission on patient data and data collection in this study.

Author contributions

The authors indicated in parentheses made substantial contributions to the following task of research Initial conception: conception and design (N.C.,S.S.); collection and interpretation of data (N.C.,S.P.S.); drafting the article or revising for important content (N.C.,S.S.); read and approved the final manuscript (N.C.,S.S.,C.C.,P.W.).

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