Hepato-Pancreato-cBilliary System- Related Procedures Profile in England

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ABSTRACT

Understanding Hepato-Pancreato-Billiary (HPB) system procedure trends is important for future treatment plans and ensure that these procedures are performed with high quality. There are no prior studies on the trends in HPB procedures in England. Accordingly, this study aimed to investigate trends in HPB procedures in England. This ecological research was conducted in England from March 1, 1999, to March 1, 2019, utilizing procedure and intervention hospital records. The difference between procedure rates in 1999 and 2019 was compared using the chi-square test. Over the period between 1999 and 2019, the number of performed procedures related to HPB system has reached 2,557,045 episodes. The rate of procedures increased by 43.4% during the study period. The highest increase was observed for gallbladder-related procedures which increased by 76.9%. The lowest increase was observed for bile-duct-related procedures which increased by 17.9%. The rate of emergency HPB system procedures increased by 17.0% during the study period. The rate of emergency gallbladder-related procedures increased by 132.2%. However, the rate of emergency procedures for other HPB system organs decreased between 11.4% and 37.8%. The age group 15-59 years contributed for 50.0% of the total number of procedures. Female patients contributed for over half of the procedures related to HPB system with 62.8%. Due to diagnostic and therapeutic advances, public health requirements, and risk factors, HPB procedures in England rose. Gallstone prevalence and surgical advances drove HPB gallbladder surgery. Due to danger and side effects, older patients (75+) had fewer HPB treatments. Women have more gallbladder and bile duct surgeries than males, thus most HPB procedures are on them. HPB treatments reduce with wellness education. Healthcare providers need HPB training and procedures.

Keywords: Bile duct; England; Gallbladder; Hepatic; Liver; Pancreas; Procedure

INTRODUCTION

Hepato-pancreatic-biliary (HPB) diseases include all diseases affecting the gallbladder, bile duct, pancreas, and liver, whether malignant or benign[1-5]. HPB diseases are prevalent gastrointestinal conditions associated with numerous complications that often require surgical treatment[6,7]. Nevertheless, surgical treatment for HPB is complex[6,8] and may require specialized training for surgeons[7]. Likewise, HPB surgery treatment decisions are complicated; they require extensive experience[9], and not all healthcare facilities conduct these procedures[6]. Following meticulous preoperative planning and assessment, HPB surgeries require prolonged working hours within a multidisciplinary healthcare team of experienced nurses, anesthesiologists, and surgeons[8]. Besides, HPB procedures are associated with considerable utilization of healthcare resources, including extended hospital stays, intensive care beds, and other resources[10,11]. These procedures are also linked with a high rate of postoperative complications[12], necessitating rapid intervention to save patients' lives[11,13,14]. Studies show that mortality rates in some HPB procedures reach 10%, and morbidity rates range from 20% to 30%[15-18].

Over the past two decades, many advancements in HPB procedures have been achieved, including minimally invasive techniques[19], robotic assistance[19,20], and incorporation of artificial intelligence (AI)[8], with many favorable outcomes and increased precision and accuracy in HPB procedures. For instance, minimally invasive surgery has improved patient outcomes[19]. Robotic HPB surgery has also been associated with improved intraoperative and postoperative conditions and reduced hospital stay[20,21]. However, the utilization of these technologies requires strict training for surgeons[22].

Similarly, the utilization of robotic surgery has increased considerably over the past two decades in England[23]. With this significant increase in surgical technical progress, it is essential to understand HPB procedure trends to inform future treatment plans and ensure that these procedures are performed with high quality. There are no prior studies on the trends in HPB procedures in England. Accordingly, this study aimed to investigate trends in HPB procedures in England.

METHOD

Study sources and the populations: This ecological research was conducted in England from March 1, 1999, to March 1, 2019, utilizing procedure and intervention hospital records. The Hospital Episode Statistics (HES) database in England provides online access to the primary procedures and intervention data for all patients admitted to NHS hospitals in England[24]. The Office for National Statistics database was used to collect mid-year population data for the same period [25]. We utilized all Censuses and Surveys Classification of Interventions and Procedures version 4 (OPCS-4) codes that were associated with the hepato-pancreato-biliary system from J01-J17, J27-J53, and J54-J68 to identify all pertinent procedures[26]. In the HES database, age groups were divided into four categories: below 15 years, 15–59 years, 60–74 years, and 75 years and above. The accuracy and validity of HES data are routinely evaluated to assure their quality, and multiple studies were conducted using these databases[24,27-30].

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Ethical approval: The study protocol (SREC/25/07/154) was approved by the research ethics committee at Isra University, Amman, Jordan. The World Medical Association (WMA) Declaration of Helsinki was adhered to during the execution of this investigation.

Statistical Analysis: We calculated procedure rates with 95% confidence intervals (CIs) by dividing the concluded consultant episodes for relevant procedures by the midyear population. The difference between procedure rates in 1999 and 2019 was compared using the chi-square test. All statistical analyses were conducted using SPSS version 29.

RESULTS

Over the period between 1999 and 2019, the number of performed procedures related to hepato – pancreato -biliary (HPB) system has reached 2,557,045 episodes. The rate of procedures increased by 43.4% during the study period. The highest increase was observed for gallbladder-related procedures which increased by 76.9%. The lowest increase was observed for bile-duct-related procedures which increased by 17.9%. The rate of emergency HPB system procedures increased by 17.0% during the study period. The rate of emergency gallbladder-related procedures increased by 132.2%. However, the rate of emergency procedures for other HPB system organs decreased between 11.4% and 37.8%. For further details on change in procedures rate during the study period stratified by organ, refer to Table 1.

Hepato – pancreato -biliary system- related procedures rate per age group

The age group 15-59 years contributed for 50.0% of the total number of procedures related to HPB system, followed by the age group 60-

Table 1. Change in procedures rate during the study period stratified by organ

Procedure and intervention type stratified by organ	Rate per 100,000 persons in 1999	Rate per 100,000 persons in 2019	Change in the rate of procedure	P-value
	Overall procedure rates			
"Hepato – pancreato -biliary system- related procedures"	**192.64**	**276.28**	**43.4%**	≤0.05
"Gallbladder-related procedures"	**77.23**	**136.59**	**76.9%**	≤0.01
"Pancreas-related procedures"	**4.0**	**6.1**	**52.7%**	≤0.05
"Liver-related procedures"	**35.01**	**45.11**	**28.9%**	≤0.05
"Bile duct-related procedures"	**76.46**	**90.15**	**17.9%**	≤0.05
	Emergency procedure rates			
"Hepato – pancreato -biliary system- related procedures"	**31.50**	**36.85**	**17.0%**	≤0.05
"Liver-related procedures"	**6.98**	**4.51**	**-35.3%**	≤0.05
"Gallbladder-related procedures"	**7.54**	**17.51**	**132.2%**	≤0.001
"Bile duct-related procedures"	**16.18**	**14.33**	**-11.4%**	≤0.05
"Pancreas-related procedures"	**0.81**	**0.50**	**-37.8%**	≤0.05

Table 2. Change in procedures rate during the study period stratified by age and organ

Procedure type	Rate per 100,000 persons in 1999	Rate per 100,000 persons in 2019	Change in the rate of procedures	P-value
	Age group below 15 years			
"Hepato – pancreato -biliary system- related procedures"	10.33	11.29	9.3%	≥0.05
"Gallbladder-related procedures"	0.84	1.59	88.7%	≤0.01
"Pancreas-related procedures"	0.26	0.27	6.0%	≥0.05
"Liver-related procedures"	7.28	7.49	2.8%	≥0.05
"Bile duct-related procedures"	1.95	1.94	-0.6%	≥0.05
	Age group 15 – 59 years			
"Hepato – pancreato -biliary system- related procedures"	156.73	231.66	47.8%	≤0.05
"Gallbladder-related procedures"	77.61	151.61	95.4%	≤0.01
"Pancreas-related procedures"	3.20	4.36	36.0%	≤0.05
"Bile duct-related procedures"	41.97	44.03	4.9%	≥0.05
"Liver-related procedures"	33.95	31.66	-6.8%	≥0.05
	Age group 60-74 years			
"Hepato – pancreato -biliary system- related procedures"	459.83	543.95	18.3%	≤0.05
"Liver-related procedures"	75.84	111.38	46.9%	≤0.05
"Pancreas-related procedures"	11.92	15.82	32.6%	≤0.05
"Gallbladder-related procedures"	173.04	226.12	30.7%	≤0.05
"Bile duct-related procedures"	199.03	190.64	-4.2%	≥0.05
	Age group 75 years and over			
"Hepato – pancreato -biliary system- related procedures"	468.90	648.35	38.3%	≤0.05
"Pancreas-related procedures"	5.43	11.47	111.3%	≤0.001
"Liver-related procedures"	41.21	86.01	108.7%	≤0.001
"Gallbladder-related procedures"	97.03	153.14	57.8%	≤0.05
"Bile duct-related procedures"	325.24	397.73	22.3%	≤0.05

74 years, and 75 years and over with 30.1% and 19.1%, respectively. The overall rate of HPB system- related procedures showed the highest increase among the age group 15-59 years with 47.8%. The lowest increase in the overall rate of HPB system- related procedures was observed among the age group below 15 years with 9.3%.

Gallbladder-related procedures showed the highest increase among patients aged below 59 years. Among the age group 60-74 years, liver-related procedures showed the highest increase in the rate of procedures with 46.9%. Among elderly patients aged 75 years and over, pancreas-related procedures showed the highest increase with 111.3%. For further details on change in procedures rate during the study period stratified by age and organ, refer to Table 2.

Hepato – pancreato -biliary system- related procedures rate per gender

Female patients contributed for over half of the procedures related to HPB system with 62.8%. During the study period, the change in the rate of procedures related to to HPB system increased similarly for males and females with 44.4% and 44.8%, respectively. Gallbladder-related procedures showed the highest increase among males with 94.6% followed by pancreas-related procedures with 54.7%. Similarly, gallbladder-related procedures showed the highest increase among females with 72.2% followed by pancreas-related procedures with 50.1%. For further details on change in procedures rate during the study period stratified by gender and organ, refer to Table 3.

Liver-related procedures

During the study period, a total of 428,133 liver-related procedures were identified. The most three commonly performed procedures were diagnostic percutaneous operations on liver, other puncture of liver, and partial excision of liver with 59.3%, 10.2%, and 8.4%, respectively, Table 4.

Gallbladder-related procedures

During the study period, a total of 1,222,400 gallbladder-related procedures were identified. The most commonly performed procedure was excision of gall bladder accounting for 98.1% of the total number of gallbladder-related procedures, Table 5.

Bile duct-related procedures

During the study period, a total of 850,461 bile duct-related procedures were identified. The most three commonly performed procedures were endoscopic incision of sphincter of oddi, Diag.endo.retrograde exam/ bile duct and pancreatic duct, and endoscopic retrograde placement of prosthesis in bile duct with 44.2%, 16.8%, and 16.3%, Table 6.

Table 3. Change in procedures rate during the study period stratified by gender and organ

Procedure type	Rate per 100,000 persons in 1999	Rate per 100,000 persons in 2019	Change in the rate of procedure	P-value
	Males			
"Hepato – pancreato -biliary system- related procedures"	149.68	216.06	44.4%	≤0.05
"Gallbladder-related procedures"	39.61	77.08	94.6%	≤0.01
"Pancreas-related procedures"	4.33	6.70	54.7%	≤0.05
"Bile duct-related procedures"	65.24	82.26	26.1%	≤0.05
"Liver-related procedures"	40.50	50.01	23.5%	≤0.05
	Females			
"Hepato – pancreato -biliary system- related procedures"	233.75	338.47	44.8%	≤0.05
"Gallbladder-related procedures"	113.19	194.87	72.2%	≤0.05
"Pancreas-related procedures"	3.61	5.43	50.1%	≤0.05
"Liver-related procedures	29.76	40.30	35.4%	≤0.05
"Bile duct-related procedures"	87.19	97.87	12.3%	≤0.05

Table 4. Proportion of liver-related procedures from total number

Liver-related procedures	Percentage from total number of liver-related procedures
"J13 Diagnostic percutaneous operations on liver"	59.3
"J14 Other puncture of liver"	10.2
"J02 Partial excision of liver"	8.4
"J12 Other therapeutic percutaneous operations on liver"	6.2
"J10 Transluminal operations on blood vessel of liver"	5.8
"J01 Transplantation of liver"	3.0
"J09 Diagnostic endoscopic examination/liver using laparoscope"	1.7
"J03 Extirpation of lesion of liver"	1.5
"J11 Transjugular intrahepatic operations on blood vessel of liver"	1.4
"J17 Endoscopic ultrasound examination of liver"	0.8
"J05 Incision of liver"	0.6
"J04 Repair of liver"	0.4
"J08 Therapeutic endoscopic operations/liver using laparoscope"	0.3
"J16 Other operations on liver"	0.1
"J07 Other open operations on liver"	0.1
"J15 Transluminal insertion of prosthesis into blood vessel of liver"	0.1
"Other transjugular intrahepatic operations on blood vessel of liver"	0.1

Table 5. Proportion of gallbladder-related procedures from total number

Gallbladder-related procedures	Percentage from total number of gallbladder-related procedures
"J18 Excision of gall bladder"	98.1
"J24 Therapeutic percutaneous operations on gall bladder"	0.95
"J21 Incision of gall bladder"	0.70
"J19 Connection of gall bladder"	0.06
"J25 Diagnostic percutaneous operations on gall bladder"	0.05
"J23 Other open operations on gall bladder"	0.05
"J26 Other operations on gall bladder"	0.05
"J20 Repair of gall bladder"	0.03

Table 6. Proportion of bile duct-related procedures from total number

Bile duct-related procedures	Percentage from total number of bile duct-related procedures
"J38 Endoscopic incision of sphincter of oddi"	44.2
"J43 Diag.endo.retrograde exam/bile duct and pancreatic duct"	16.8
"J40 Endoscopic retrograde placement of prosthesis in bile duct"	16.3
"J41 Other therapeutic endoscopic retrograde operations on bile duct"	6.1
"J47 Therapeutic percutaneous insertion/prosthesis into bile duct"	2.8
"J53 Endoscopic ultrasound examination of bile duct"	2.3
"J48 Other therapeutic percutaneous operations on bile duct"	2.0
"J50 Percutaneous examination of bile duct"	1.8
"J44 Diagnostic endoscopic retrograde examination of bile duct"	1.6
"J42 Therapeutic endo.retrograde operations/pancreatic duct"	1.5
"J45 Diagnostic endoscopic retrograde exam/pancreatic duct"	1.0
"J39 Other therapeutic endoscopic operations on ampulla of v"	0.6
"J29 Connection of hepatic duct"	0.5
"J33 Incision of bile duct"	0.4
"J35 Incision of sphincter of oddi using duodenal approach"	0.4
"J37 Other open operations on bile duct"	0.3
"J34 Plastic repair/sphincter of oddi using duodenal approach"	0.3
"J30 Connection of common bile duct"	0.2
"J32 Repair of bile duct"	0.2
"J46 Therapeutic percutaneous attention to connection/bile duct"	0.1
"J52 Other operations on bile duct"	0.1
"J36 Other operations on ampulla of vater using duodenal approach"	0.1
"J27 Excision of bile duct"	0.1
"J31 Open introduction of prosthesis into bile duct"	0.1
"J28 Extirpation of lesion of bile duct"	0.1
"J49 Therapeutic operations on bile duct along t tube track"	0.1
"J51 Laparoscopic ultrasound examination of bile duct"	0.01

Table 7. Proportion of pancreas-related procedures from total number

Pancreas-related procedures	Percentage from total number of pancreas-related procedures
"J56 Excision of head of pancreas"	36.4
"J57 Other partial excision of pancreas"	15.4
"J66 Therapeutic percutaneous operations on pancreas"	14.1
"J67 Diagnostic percutaneous operations on pancreas"	10.8
"J61 Open drainage of lesion of pancreas"	8.2
"J65 Other open operations on pancreas"	5.8
"J55 Total excision of pancreas"	2.4
"J58 Extirpation of lesion of pancreas"	2.0
"J59 Connection of pancreatic duct"	1.8
"J54 Transplantation of pancreas"	1.5
"J60 Other open operations on pancreatic duct"	1.2
"J63 Open examination of pancreas"	0.3
"J62 Incision of pancreas"	0.1

Pancreas-related procedures

During the study period, a total of 56,051 pancreas-related procedures were identified. The most three commonly performed procedures were excision of head of pancreas, other partial excision of pancreas, and therapeutic percutaneous operations on pancreas with 36.4%, 15.4%, and 14.1%, Table 7.

DISCUSSION

This study examined the trends in HPB procedures in England, underscored the change in the HPB procedures rate, and the distribution of procedures by HPP organ and patients' demographics. We found that the rate of HPB procedures increased by 43.4% in England during the study period. In line with this, the number of HPB procedures in the United States (U.S.) increased by approximately 28% from 1998 to 2019[31]. Similarly, the number of HPB procedures performed by chief residency graduates in the U.S. increased by 21% from 2003 to 2012[32]. A previous study revealed that these increases in HPB procedures are attributed to several factors, including market conditions shifts, treatment advancements, and demographic changes[33], which may likewise cause increases in HPB procedures in our study.

Surgical procedures for HPB have advanced considerably over the past two decades, with robotic surgery and other minimally invasive technologies improving accuracy and precision for procedures and associated with better patient outcomes[19,34,35]. In addition, earlier research indicates that advances in HPB diagnostic technologies, particularly AI-enhanced surgical techniques, are associated with more accurate and personalized procedures[8]. Similarly, in the UK, statistics indicate changes in the population's health needs[36] and changes in risk factors, including smoking, diet, physical activity, obesity, alcohol consumption, and others[37]. Besides, the use of robotic surgery in England increased by more than 400% between 2013 and 2019[23]. Therefore, it is necessary to encourage individuals to adopt healthy lifestyles to reduce the need for HPB procedures resulting from unhealthy habits. It is also mandatory to ensure that healthcare providers have adequate experience and training on advancements in HPB procedures and that the number of HPB specialists corresponds to the number of patients, enabling them to provide timely care before the condition worsens. These, in turn, aid in preserving patients' health and quality of life (QoL) and health service resources. Finally, implementing the time-specific diagnostic pathway for HPB cancer, as outlined by the NHS[38], could produce numerous positive outcomes for patients, healthcare providers, and resources.

Another important finding is that the highest increase was observed for gallbladder-related procedures, which increased by 76.9%. Pancreas and liver-related procedures increased by 52.7% and 28.9%, respectively. The lowest increase was observed for bile-duct-related procedures, which increased by 17.9%. Gallbladder-related procedures showed the highest increase among males, with 94.6%, followed by pancreas-related procedures, with 54.7%. Similarly, gallbladder-related procedures showed the highest increase among females, with 72.2%, followed by pancreas-related procedures, with 50.1%. Besides, diagnostic percutaneous operations on the liver, excision of the gallbladder, endoscopic incision of the sphincter of Oddi, and excision of the head of the pancreas, were the most common procedures related to liver, gallbladder, bile duct, and pancreas, respectively. There are several explanations and comparable findings from previous research.

In the U.S., pancreatic surgeries increased by 47%, liver by 31%, and bile duct surgeries by 14%[39], closely resembling our findings. The laparoscopic cholecystectomy ratio also increased significantly in France[40]. On the other hand, liver resections increased by 69% and pancreatic resections by 33% in North America from 2006 to 2010[41]. In another previous study in the U.S., the average number of bile duct surgeries conducted by chief residency graduates decreased while the average number of liver and pancreatic procedures increased[32]. These discrepancies between study results may be due to differences in demographics, lifestyles, health resources, and study period. Nevertheless, interventions are required to reduce the need for HPB procedures in diverse countries.

Earlier studies and statistics in the UK and England have declared several findings that are consistent with and explain our findings. Firstly, regarding gallbladder procedures, from 2000 to 2019, the number of gallbladder procedures in England increased by approximately 80%[42]. As noted in our study, gallbladder excision was the most common of these procedures. The rise in gallbladder excision reflects the increase in gallstone prevalence, with over 10% of the adult UK population estimated to suffer from gallstones[43]. It may also reflect the substantial advancements in this procedure, as studies have revealed a rise in laparoscopic gallbladder excision in England[42] and promising outcomes for robotic gallbladder excision in the UK[44]. Hence, increasing public awareness of gallstone risk factors and consequences may help mitigate these trends[45].

Secondly, the increase in pancreatic procedure rates in our study is in line with the upsurge in pancreatic cancer cases in the UK, with approximately 5,600 to 5,200 new cases reported in both males and females each year[46]. Besides, cancer of the head of the pancreas accounts for the bulk of pancreatic cancer cases in the UK[46], which may explain the preponderance of pancreatic head resection among pancreatic procedures in our study. Still, research has reported that between 12% and 22% of pancreatic cancer cases in the UK emerged as a result of drinking more than three units of alcohol per day[47,48], obesity, overweight, and/or smoking[49]. Thus, creating awareness programs for such risk factors can assist in decreasing the incidence of pancreatic cancers, reducing the need for pancreatic procedures, and conserving healthcare resources.

Thirdly, the rise in liver procedures in this study accords with evidence indicating an increase in liver resections[50], hospital admissions for liver disease[51,52], and liver cancer cases[53] in England. As these trends increase, the need to diagnose liver disease also grows, which explains why diagnostic percutaneous operations on the liver were the primary liver procedure in England during our study time. Prior research has demonstrated discrepancies in access to liver procedures among populations across diverse regions in England[50]. Accordingly, there is a need to ensure equitable access to these procedures. In addition, most liver diseases in the UK are preventable, with 90% of these diseases being attributable to viral hepatitis, obesity, and alcohol consumption[54]. Hence, implementing preventive measures for liver disease will help reduce these diseases and, consequently, decrease the need for liver procedures.

Fourthly, although the increase in bile duct procedures was lowest for HPB-related procedures, it still indicates a need to reduce procedures for bile ducts. Endoscopic incision of the sphincter of Oddi, which was the most common bile duct procedure, include "endoscopic sphincterotomy of sphincter of Oddi and removal of calculus HFQ," "endoscopic sphincterotomy of sphincter of Oddi and insertion of tubal prosthesis into bile duct," "other specified endoscopic incision of sphincter of Oddi," and "unspecified endoscopic incision of sphincter of Oddi." Endoscopic sphincterotomy is frequently utilized to treat several problems and remove bile duct stones[55,56]. The literature indicates that approximately 10% to 20% of symptomatic gallstone patients develop bile duct stones[57-61]. Besides, primary bile duct

stones are rare[58,62,63]. As gallstones grow in England, bile duct stones will also grow, but less than gallstones. These may explain the more considerable increase in gallbladder procedure rates compared to bile duct procedures. Still, there is a lack of standardization for utilizing endoscopic retrograde cholangiopancreatography (ERCP) for bile duct stone removal, resulting in repeated procedures in over half of these cases in England[64]. This lack of standardization could contribute to the increase in the rate of the bile duct procedure. Therefore, there is a need to standardize these procedures in England.

The current study found that the rate of emergency HPB system procedures increased by 17.0% throughout the study. The rate of emergency gallbladder procedures increased by 132.2%, while the rate of emergency procedures for the remaining HPB system organs declined between 11.4% and 37.8%. This could be due to the increase in the utilization of early laparoscopic cholecystectomy following treatment guidelines, which increased the need for emergency procedure. On the other hands, pancreas and bile-duct related procedure rate declined due to the non-interventional nature applied to manage these cases such as endoscopy. The increase in the number of populations could be another contributing factor. Aligned with our findings, elective surgery accounted for the bulk of HPB surgery in Indonesia[65]. In England, approximately 33% of general emergency surgery referrals and admissions are due to gallstone disease[66], with an emerging trend in emergency admissions[45]. Furthermore, open cholecystectomy is also frequently performed under emergency conditions in England[67]. Gallstone patients often experience significant delays in their surgery due to the high prevalence of the disease in England, requiring emergency surgery to prevent severe complications, mitigate the financial burden on healthcare providers, and improve patient outcomes[68]. Nevertheless, an earlier study in England reported discrepancies in emergency surgery rates by age and NHS trusts[69]. Therefore, implementing effective interventions to address these discrepancies is critical.

In our study, the age group 15-59 years contributed 50.0% of the total number of procedures related to the HPB system, followed by the age group 60 to 74 years and 75 years and over with 30.1% and 19.1%, respectively. In line with the present results, a previous study in Pakistan demonstrated that the mean age for complex bile duct surgery was 40 years (range 21-65)[70]. These declines in rates of HPB procedures with increasing patient age may be attributed to increased risks associated with comorbidities, frailty, and anesthesia complications[45]. Besides, the risk of re-admission after HPB procedures is higher in elderly patients, and the risk is even higher with multiple comorbidities[71]. These findings underscore the significant challenges of HPB procedures in elderly patients[71]. Thus, weighing the potential risks and benefits of HPB procedures for elderly patients is required for achieving optimal outcomes. In addition, given the association of HPB procedures with unhealthy lifestyle habits, campaigns and advertisements that promote a healthy lifestyle will aid in diminishing the need for HPB procedures in all age groups.

This study showed that female patients contributed to over half (62.8%) of the procedures related to the HPB system. This finding matches those observed in earlier studies. For instance, females accounted for most HPB procedures in Indonesia (55%)[65], complex bile duct procedures in Pakistan (81%)[70], robotic gallbladder excision procedures in the UK (73%)[44], and gallbladder excision procedures in France (67%)[40]. These statistics identify female sex as a risk factor for gallbladder and bile duct procedures; thus, our result reflects the higher volume of these procedures in England throughout the study. Consistent with these, prior research documented that females have 2 to 3-fold higher rates of gallstones than males[72]. On the other hand, the incidence of liver and pancreas diseases was reported to be higher among males than females[73,74], suggesting higher liver and pancreas procedures among males. Therefore, targeted interventions to decrease gallbladder and bile duct procedures must focus on females, while those for liver and pancreas procedures must focus on males.

This study has limitations. The ecological study design using population level data has limited ability to identify confounding variables that might have led to the increase in procedure rate observed in this study. Therefore, the study findings should be interpreted carefully.

CONCLUSION

Over this study period, there was an increase in HPB procedures in England, reflecting advances in diagnostic and therapeutic techniques, changes in the population's health needs, and a rise in risk factors. The highest increase in HPB procedures was in gallbladder procedures, which correlated with the increased prevalence of gallstones and the advances in gallbladder surgical techniques. The older patients (aged 75 years and above) accounted for a lower percentage of HPB procedures than those aged below 75 due to the increased risk and complications associated with procedures for older patients. Most HPB procedures were performed among female patients because of the preponderance of gallbladder and bile duct procedures, which are higher among females than males. Educational activities that encourage the population to adopt healthy lifestyles are needed to reduce the need for HPB procedures. Besides, it is necessary to ensure that healthcare providers are adequately trained and that populations have equitable access to HPB procedures.

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Competing Interest: None

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