ORIGINAL ARTICLE

Assessing the Role of Community-Based Screening in Early Detection of Hepatocellular Carcinoma in Hepatitis B and C at a Tertiary Care Hospital

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ABSTRACT

Background: Hepatocellular carcinoma (HCC) is a major cause of cancer-related mortality worldwide, especially in countries with a high burden of hepatitis B virus (HBV) and hepatitis C virus (HCV) infections. In Pakistan, late-stage diagnosis remains a significant challenge due to limited surveillance and delayed access to tertiary care. Community-based screening offers a promising approach to detect HCC at earlier, more treatable stages.
Objective: To evaluate the effectiveness of community-based hepatitis screening in the early detection of HCC among HBV- and HCV-infected patients referred to a tertiary care hospital.
Methods: This cross-sectional observational study was conducted at Bolan Medical University Hospital, Quetta, from June 2022 to June 2023. A total of 70 patients aged 30–70 years with HBV or HCV infection were referred from rural community screening camps. All underwent abdominal ultrasound, serum alpha-fetoprotein (AFP) testing, and contrast-enhanced MRI/CT where indicated. Diagnosed HCC cases were staged using the Barcelona Clinic Liver Cancer (BCLC) system.
Results: Of the 70 patients, 14 (20%) were diagnosed with HCC. Among these, 9 patients (64.3%) were classified as BCLC Stage A, 3 (21.4%) as Stage B, and 2 (14.3%) as Stage C. No patients presented at Stage D. Early-stage detection was notably higher than in typical hospital-based presentations.
Conclusion: Community-based screening significantly improves early-stage detection of HCC in high-risk populations. Integrating ultrasound and AFP testing into outreach programs may shift diagnosis to curative stages and reduce liver cancer mortality in resource-limited settings.
Keywords: Hepatocellular carcinoma, community screening, hepatitis B, hepatitis C, BCLC staging, early detection, Pakistan, tertiary hospital

INTRODUCTION

Hepatocellular carcinoma (HCC), the primary malignancy of the liver, is a major global health concern and the third leading cause of cancer-related deaths worldwide. The incidence of HCC is strongly linked to chronic infection with hepatitis B virus (HBV) and hepatitis C virus (HCV), both of which are highly prevalent in low- and middle-income countries (LMICs), including Pakistan[1]. In Pakistan alone, it is estimated that over 12 million individuals are living with chronic hepatitis B or C, placing them at a high risk of developing cirrhosis and, eventually, hepatocellular carcinoma. Despite advancements in antiviral therapy and the availability of surveillance guidelines, the majority of liver cancers in Pakistan continue to be diagnosed at late stages, resulting in poor treatment outcomes and high mortality[2].

The prognosis of HCC is largely determined by the stage at which the cancer is detected. Early-stage HCC is potentially curable with surgical resection, liver transplantation, or local ablative therapies, but these options are often not feasible in patients who present with advanced disease[3]. Unfortunately, most patients in resource-limited settings are diagnosed only after the development of symptoms, by which time the tumor burden has progressed beyond curative intervention. This delay is often due to the absence of structured surveillance programs, low health literacy, socioeconomic barriers, and limited access to tertiary healthcare facilities, particularly in rural and underserved regions[4].

Recognizing this gap in early detection, public health strategies have increasingly emphasized the role of community-based screening as a proactive approach to identify individuals at risk of HCC. Community-based screening refers to organized, population-level initiatives conducted outside of hospital settings, aiming to identify individuals with chronic liver disease or HCC in asymptomatic stages[5]. These programs typically involve mass hepatitis B and C screening through rapid diagnostic tests,

followed by confirmatory testing and basic imaging (e.g., abdominal ultrasound), with referrals made to tertiary care centers for further evaluation and management. Such programs have the potential to shift the diagnostic paradigm from reactive hospital-based care to preventive community-centered healthcare[6].

While community-based screening programs for viral hepatitis have been successfully implemented in several countries, data on their effectiveness in early detection of HCC within the Pakistani population remain scarce[7]. Most existing surveillance efforts in Pakistan are opportunistic, lacking in coverage, continuity, and linkage to specialized care. There is a pressing need to evaluate whether structured community-based screening efforts can lead to earlier detection of HCC in high-risk populations, thereby enabling timely treatment and reducing disease-specific mortality[8].

This study was therefore designed to assess the effectiveness of community-based screening in the early diagnosis of HCC among patients with chronic HBV and HCV infection. Conducted at a tertiary care hospital in Lahore, Pakistan, the study compares clinical outcomes and cancer staging between patients identified through outreach screening programs and those who presented directly to hospital services without prior community-level screening. By analyzing differences in diagnostic stage, the study aims to provide empirical evidence supporting the integration of community-based screening strategies into national liver cancer control programs, ultimately improving patient survival and public health outcomes in Pakistan[9].

MATERIALS AND METHODS

Study Design and Setting: This study was designed as a cross-sectional observational analysis conducted at Bolan Medical University Hospital, Quetta, a tertiary care referral center in Balochistan, Pakistan. The aim of the study was to evaluate the role of community-based screening in the early detection of hepatocellular carcinoma (HCC) among individuals with chronic hepatitis B and C infections. The study was carried out over a 12-month period from June 2022 to June 2023. Community screening

camps were organized by the hospital in collaboration with local primary healthcare units to identify undiagnosed cases of HBV and HCV in rural and peri-urban communities surrounding Quetta.

Study Population and Sampling Method: A total of 70 patients were enrolled in the study using non-probability consecutive sampling. These patients were identified as hepatitis B surface antigen (HBsAg) positive or anti-HCV antibody positive during the community screening initiative and were subsequently referred to the hepatology department at Bolan Medical University Hospital for further assessment. The study population included both male and female adults between the ages of 30 and 70 years. Eligibility was restricted to individuals who tested positive for HBV or HCV, had no prior history of hepatocellular carcinoma, and consented to undergo further diagnostic evaluation.

Inclusion and Exclusion Criteria: Participants included in the study were aged between 30 and 70 years, tested positive for HBV (as confirmed by HBsAg) or HCV (confirmed by both anti-HCV and HCV RNA positivity), and were naïve to HCC diagnosis or treatment. Individuals with co-infection of HIV, non-viral liver diseases such as autoimmune hepatitis or alcoholic liver disease, those previously diagnosed with HCC, and patients unwilling to give informed consent were excluded from the study. Additionally, participants with incomplete diagnostic records or who could not complete the imaging protocol were also excluded from final analysis.

Screening and Diagnostic Workup: After referral from the community screening camps, all enrolled patients underwent a structured diagnostic workup at the tertiary care facility. Initial laboratory investigations included liver function tests, complete blood count, serum alpha-fetoprotein (AFP) levels, and viral load testing (HBV DNA or HCV RNA PCR as appropriate). Abdominal ultrasonography was performed as the primary imaging modality for all patients to evaluate the liver architecture and detect any suspicious lesions. In patients with elevated AFP levels (>20 ng/mL) or detection of focal liver lesions ≥1 cm on ultrasound, contrast-enhanced magnetic resonance imaging (MRI) or computed tomography (CT) scan was conducted to confirm the diagnosis of HCC. All diagnosed cases of HCC were staged according to the Barcelona Clinic Liver Cancer (BCLC) staging system.

Data Collection and Ethical Considerations: Clinical, demographic, and diagnostic data were collected using a standardized data collection form. Information gathered included age, sex, place of residence, viral status (HBV or HCV), laboratory test results, imaging findings, and HCC staging. Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Bolan Medical University, Quetta. All participants provided written informed consent before enrollment. Patient confidentiality was maintained throughout the study and data were anonymized prior to analysis.

Statistical Analysis: The collected data were entered and analyzed using SPSS version 25. Descriptive statistics were used to summarize patient demographics, viral hepatitis status, and HCC staging. Mean and standard deviation were calculated for continuous variables such as age and AFP levels, while frequencies and percentages were used for categorical variables. The primary outcome of interest was the proportion of patients diagnosed with early-stage HCC (defined as BCLC Stage A) among those screened through community-based programs. Where applicable, chi-square tests were used to compare early detection rates with historical hospital-based controls. A p-value of less than 0.05 was considered statistically significant.

RESULTS

This cross-sectional study enrolled a total of 70 patients who were identified through community-based hepatitis B and C screening camps and subsequently referred to Bolan Medical University Hospital, Quetta, for further evaluation between June 2022 and June 2023. The study population comprised 42 males (60%) and 28 females (40%), with a mean age of 52.6 ± 8.7 years. The majority of participants (n = 51, 72.9%) belonged to rural areas, while only 19 patients (27.1%) were from urban locations. Chronic HCV infection was more prevalent among the screened individuals, with 46 patients (65.7%) testing positive for anti-HCV antibodies and confirmed via HCV RNA PCR testing, whereas 24 patients (34.3%) were positive for hepatitis B surface antigen (HBsAg). This distribution aligns with regional data indicating a higher prevalence of HCV in Balochistan. Table 1 summarizes the baseline demographic and clinical profile of the study participants, highlighting key characteristics such as age, gender, residential background, viral status, and laboratory findings.

Table 1: Baseline Demographic and Clinical Characteristics of Patients (n = 70)

Variable	Frequency (n)	Percentage (%)
Mean Age (years)	52.6 ± 8.7	—
Gender (Male)	42	60.0
Gender (Female)	28	40.0
HBV Positive	24	34.3
HCV Positive	46	65.7
Rural Residence	51	72.9
Urban Residence	19	27.1
AFP > 20 ng/mL	10	14.3
Suspicious Liver Lesions (USG)	18	25.7
HCC Confirmed (MRI/CT)	14	20.0

Ultrasonographic examination of all participants was performed to evaluate liver morphology and detect possible hepatic focal lesions. Liver lesions suspicious for hepatocellular carcinoma were identified in 18 patients (25.7%), prompting further investigation with advanced imaging modalities. In parallel, serum alpha-fetoprotein (AFP) levels were measured as part of the diagnostic workup, and elevated AFP levels greater than 20 ng/mL were found in 10 individuals (14.3%). Those who either had elevated AFP levels or liver lesions detected on ultrasound underwent contrast-enhanced magnetic resonance imaging (MRI) or computed tomography (CT) scan to confirm or exclude hepatocellular carcinoma. Based on these advanced imaging results, a definitive diagnosis of HCC was established in 14 patients, representing 20.0% of the total sample. This detection rate underscores the value of combining biochemical and radiological approaches within community-screened individuals for early cancer diagnosis.

Following diagnosis, each confirmed case of HCC was classified according to the Barcelona Clinic Liver Cancer (BCLC) staging system to determine the disease extent and guide clinical decision-making. Among the 14 diagnosed cases, 9 patients (64.3%) were categorized as BCLC Stage A, indicating early-stage, localized tumors amenable to potentially curative therapies such as surgical resection, liver transplantation, or percutaneous ablative techniques. Three patients (21.4%) were classified as Stage B, characterized by multinodular disease without vascular invasion, typically managed through transarterial chemoembolization (TACE). Two patients (14.3%) were staged as BCLC Stage C, reflecting advanced disease with vascular invasion or extrahepatic spread, and thus more limited therapeutic options. Importantly, none of the patients were diagnosed at BCLC Stage D, which signifies terminal disease with severely impaired liver function and limited survival (Table 2).

Table 2: BCLC Staging of Confirmed HCC Cases (n = 14)

BCLC Stage	Number of Patients	Percentage (%)
Stage A	9	64.3
Stage B	3	21.4
Stage C	2	14.3
Stage D	0	0.0

The staging distribution presented in Table 2 reveals a significant proportion of patients diagnosed at an early stage of hepatocellular carcinoma, which is highly encouraging from a public health and clinical perspective. The predominance of Stage

A diagnoses (64.3%) contrasts sharply with patterns typically observed in hospital-based or symptom-prompted presentations, where patients often present at advanced or terminal stages due to delayed access to care. This shift toward early-stage detection among patients identified through community-based screening programs highlights the effectiveness of proactive hepatitis surveillance and the critical role of outreach diagnostics in high-risk populations. Furthermore, the absence of any Stage D diagnoses reflects the benefits of early referral and structured diagnostic follow-up, which allowed timely identification of liver malignancy before clinical deterioration.

Taken together, the results demonstrate that community-based screening not only enables detection of chronic HBV and HCV infections in undiagnosed individuals but also facilitates early recognition of hepatic malignancies in those at risk. With 20% of the screened population being diagnosed with HCC—most at an early, treatable stage—this study affirms the pivotal role of integrating basic diagnostic tools such as abdominal ultrasound and AFP testing into community outreach programs. This approach holds the potential to dramatically alter the clinical trajectory of liver cancer in Pakistan's underserved populations by shifting diagnosis from palliative to curative stages.

DISCUSSION

This study highlights the significant impact of community-based screening on the early detection of hepatocellular carcinoma (HCC) in patients with chronic hepatitis B and C infections. Conducted at a tertiary care hospital in a resource-limited setting, the findings clearly demonstrate that systematic outreach and diagnostic efforts in the community can shift the clinical stage at diagnosis toward early, potentially curable disease[10]. Of the 70 patients referred from hepatitis screening camps, 14 (20%) were diagnosed with HCC, and the majority of these (64.3%) were found to be in BCLC Stage A. These results stand in stark contrast to prior institutional trends in Pakistan, where patients commonly present with symptomatic, advanced-stage disease due to late diagnosis, lack of awareness, and poor access to hepatology care[11].

The predominance of HCV infection (65.7%) over HBV (34.3%) in our screened population aligns with national seroprevalence data and underscores the heavy burden of undiagnosed chronic HCV in Pakistan, particularly in rural provinces such as Balochistan. The fact that over 70% of our study participants originated from rural areas reflects the geographical and healthcare disparities in liver disease diagnosis[12]. These underserved populations often lack access to routine laboratory testing, imaging modalities, or specialized gastroenterology consultations. Community-based screening camps, in this context, serve as critical interventions that overcome socioeconomic and infrastructural barriers by bringing diagnostic services closer to the population at risk[13].

One of the key findings of our study is the high rate of early-stage HCC detection, with 64.3% of HCC patients classified as BCLC Stage A. This is particularly noteworthy given the often asymptomatic nature of early HCC and the limited sensitivity of basic screening modalities. The use of abdominal ultrasound in combination with serum alpha-fetoprotein (AFP) testing provided a cost-effective, feasible approach for mass screening[14]. Despite their individual limitations, when used together in a structured screening program, these tools proved valuable in identifying at-risk individuals and detecting small hepatic lesions requiring further evaluation. The follow-up with contrast-enhanced MRI or CT imaging ensured diagnostic accuracy, enabling prompt staging and treatment planning[15].

Compared to hospital-based cohorts in Pakistan, where most patients are diagnosed at BCLC Stage C or D and thus limited to palliative care, the early-stage detection rates in this study emphasize the transformative role of community interventions in altering disease trajectory. Our findings are consistent with global studies that have demonstrated the

effectiveness of surveillance programs in high-risk populations, such as cirrhotic patients or those with chronic hepatitis[16]. For example, studies from Japan, Taiwan, and Korea have reported improved survival rates in patients enrolled in regular surveillance compared to those diagnosed symptomatically. While such programs are often resource-intensive in high-income countries, our study demonstrates that similar principles can be adapted using basic diagnostics in low-resource settings, with meaningful clinical impact[17].

Moreover, the absence of BCLC Stage D cases among our diagnosed patients reflects a major success in early engagement and referral. Timely diagnosis not only allows for curative treatments but also provides an opportunity to initiate antiviral therapy for HBV or HCV, potentially arresting disease progression and reducing recurrence. Given that liver transplantation and surgical resection are largely unavailable or inaccessible for most patients in Pakistan, early-stage detection offers the best chance for local therapies such as radiofrequency ablation, transarterial chemoembolization (TACE), or percutaneous ethanol injection[18, 19].

However, our study also has several limitations. The sample size was modest (n = 70), and the findings may not be generalizable to all regions of Pakistan. Furthermore, while community-based screening was effective in early HCC diagnosis, long-term follow-up data regarding treatment outcomes and survival were not included in this analysis. Additionally, the study lacked a control group of hospital-presenting patients for direct statistical comparison. Future studies should aim to expand screening coverage, evaluate long-term survival benefits, and perform cost-effectiveness analyses to guide national policy formulation[20, 21].

Despite these limitations, our study contributes valuable evidence to the growing body of literature supporting decentralized, community-integrated liver cancer screening in high-risk populations. It also emphasizes the critical need for strategic partnerships between tertiary care institutions, primary health centers, and local health authorities to improve liver health outcomes in Pakistan[22].

CONCLUSION

This study provides strong evidence that community-based screening for hepatitis B and C plays a pivotal role in the early detection of hepatocellular carcinoma. Among 70 patients referred through structured outreach programs, 14 were diagnosed with HCC, with a substantial majority (64.3%) detected at an early stage (BCLC Stage A). These findings highlight the effectiveness of community-level interventions in improving diagnostic timing, especially in rural and underserved populations. The integration of simple, accessible tools—such as ultrasound and AFP testing—into community screening strategies offers a practical model for liver cancer surveillance in low-resource settings. Expanding such programs could lead to earlier treatment, improved survival, and reduced cancer burden in hepatitis-endemic regions. Policymakers and healthcare leaders are urged to prioritize community-based hepatitis screening as a core component of national liver cancer control programs.

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