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HEPATITIS C VIRUS GENOTYPE 3 IN PAKISTAN: SOCIO-DEMOGRAPHIC, OCCUPATIONAL, AND CLINICAL CHARACTERIZATION OF A COHORT IN AN ENDEMIC SETTING

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Abstract

Background: *Understanding and controlling the endemic HCV burden in Pakistan necessitate investigation of various social and structural determinants of transmission. Despite the poor prognosis (rapid steatosis) in patients infected with Genotype 3, lack of the relevant demographic and occupational information prevents efficient control measures in highly endemic settings.*

Methods: *Forty-two patients with genotype 3 of HCV at GIMS Hospital, Gambat, were assessed for socio-demographic profile, housing situation, lifestyle patterns and occupational classification into 18 various sectors of life and processed with SPSS version 26.*

Results: *This epidemic shows highest concentration in males of active age group of 30-40 years (52.4%). Majority of population belonged to the dense, joint-family type of households (66.7%), while major occupational concentration of the population under study showed association with agricultural sector (21.4%) and paramedics (19.0%), indicating clear possibility of hospital exposure and community transmission. A marked association with tobacco addiction (28.6%) was seen, while alcohol consumption was found very low (4.8%).*

Conclusion: *A joint action at family and occupational level is to be addressed and policy makers must be vigilant to prevent HCV Genotype 3 transmission by: enforcing obligatory screening in paramedics of hospitals, in members of a joint family at one and in case of a positive spouse.*

1. Introduction

Among all infectious diseases in contemporary medicine, Hepatitis C Virus (HCV) ranks among the most dangerous (Manns et al., 2021). HCV leads to more chronic liver disease, cirrhosis, and liver cancer (hepatocellular carcinoma) than any other virus (Spearman et al., 2022). HCV accomplishes this with a clinically clever strategy. The virus displays a lot of genetic variability and therefore a lot of flexibility (Cudini et al., 2023). Infected patients often remain asymptomatic. This allows the HCV virus to slowly damage the liver for decades before any symptoms are clinically noticeable.

The arrival of direct-acting antiviral (DAA) treatments has improved the global treatment of HCV (Aghemo & Lazarus, 2022). Unfortunately, the burden of HCV is still disproportionately high in many low- and middle-income countries (LMIC). Many of these

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barriers are systematic. Poor infrastructure, lack of screening, poor linkage and retention to care and treatment, maintain high rates of infection in the poorest and most vulnerable populations (Blach et al., 2022).

Pakistan has one of the highest rates of HCV in the world (Niyomsri et al., 2025). Unlike other countries, Western or otherwise, who have concentrated epidemics affecting discrete risk populations, in Pakistan HCV is a generalized epidemic (Saeed et al., 2023). Dispersed HCV epidemics are in the urban and rural population in Pakistan regardless of socioeconomic status. Poor medical practices like the reuse of medical and therapeutic injections, poor blood transfusion practices, and a reliance on unregulated informal healthcare, have created an entrenched national health crisis in Pakistan (Qureshi et al., 2022).

HCV comprises 8 genotypes and several subtypes with notable differences in global distribution and their epidemiological and therapeutic implications (Gower et al., 2024). In South Asia, and Pakistan especially, the molecular epidemiology of HCV is dominated by Genotype 3 (Khan et al., 2022). This is in contrast to Europe and North America, where Genotype 1 is the most common (Thomas et al., 2024). This distinction is clinically relevant. Genotype 3 is the most aggressive from a metabolic perspective (Al-Qahtani et al., 2023). Fibrosis progresses faster; the prevalence and severity of hepatic steatosis and hepatocellular carcinoma are greater in Genotype 3 (Butt et al., 2023). Genotype 3's direct mechanism is lipotropic and thereby aggressive. HCV alters lipid metabolism and reduces the activity of the microsomal triglyceride transfer protein, causing steatosis and fatty liver changes without the common metabolic disorders such as obesity and diabetes (Siphepho et al., 2021). Genotype 3 was the so-called "uncurable" since inadequate SVR was sustained and treatment was prolonged (Saraswat et al., 2021). Despite the global adoption of DAAs, Genotype 3 remain a difficult to treat "untreatable" target especially in the developing countries where accurate estimation of VBL, LP severity and hepatic architecture are crucial for decision making (Shah et al., 2024).

Macro-epidemiology of HCV involves examining structural and socio-demographic forces which influence the spread of the infection within the community (Cooke et al., 2021). Information provided by age and gender seems useful (Mahmoud et al., 2023). Endemic populations show concentration of the burden of disease in working aged people in their thirties and forties; this indicates the influence of age associated risk factors (Javed et al., 2024). Occupational risk among this age group was highest through the repeated contacts with the health care sector, grooming in the community and by use of force. The risk by gender is an important risk stratification and Males seem to pose higher risks because of increased occupational risk and structural mobility as well as use of barbers for grooming (Hamid & Umar, 2022). Females' risk factors include iatrogenic issues (obstetrics performed under sub-optimal conditions) and increased exposure in closed family structures.

Daily life micro-environments add to the dangers (Vento, 2026). For instance, farm workers and other labourers in rural and semi-urban areas usually function at a great distance from the formal healthcare system, this way they very often turn to informal practitioners who re-use instruments without proper sterilization (Tafti et al., 2023). In multi-generational joint-family living arrangements in South Asian households, there is a considerable vector for non-sexual and non-parenteral transmission that is not sufficiently recognized. The sharing of personal grooming items such as razors, nail clippers, and toothbrushes is a regular means of low-dose micro-inoculation among family members (Waheed et al., 2022). That means, it is the social fabric that largely keeps the clustering of infections in kinship networks going.

One of the most striking features of the HCV epidemic in endemic regions is the continuous transmission of the virus through human contact or from hospital or healthcare acquired infections (Kondili et al., 2021). Hospitals and healthcare centers, which ideally should be places where one receives treatment, are unfortunately turn into places or focus points of transmission of the virus when infection control practices are not properly observed or disappear (El-Sayed et al., 2022). This exposure through hospitals to the risk of infection is even more pronounced or severe among the staff who

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basically are the ones to be most exposed to human blood and that is the source of the pathogens in question: attending boys/cleaners, nurses, and laboratory technicians, among others, who may be exposed to contaminated clinical waste, may suffer needle-stick injuries, and be in contact with infected injection instruments (Krajden et al., 2023).

The appearance of groups or the formation of HCV cases among healthcare workers is an indication of the difference between what is written and laid down as standard practice of universal precautions and the actual implementation of these precautions in the wards (Asif et al., 2022). In addition, to these main reasons, the overcrowded wards situation, lack of PPE leading to improper sharps disposal, and lack of infection control training altogether create an environment in which accidental infection is an almost daily occupational risk. And this is just the healthcare workers' part of the story: when healthcare workers get infected, they can, without intending to become the means of patient-to-patient cross-contamination. By ending this cycle of hospital transmission, progress toward reducing the disease burden in endemic countries can be made (Umar et al., 2023).

Population level prevalence rates can provide a general overview but can sometimes mask local risk factors and unique transmission dynamics occurring within specific regional populations. Specific patient demographic, occupational, household structure, and baseline clinical marker data are essential for developing targeted, setting specific interventions (Isakov et al., 2023). The overall aim of the study was to completely characterize a group of 42 lab confirmed, HCV Genotype 3 positive patients being assessed for clinical evaluation at a regional endemic clinic. The following goals were established: Determine age, sex distribution to find at which stage of life, and which age/sex group bears the highest infection burden. Categorize occupation to recognize at which workplace associated hospital-acquired, work related, and job-related infections are at their maximum potential. Record behavioural aspects, history of substance abuse, and the nature of household structures to distinguish community from intra familial transmission. Quantify pre-treatment viral load and Fibroscan derived hepatic steatosis levels as indicative markers of pathogenic expression of Genotype 3 in the tested population. The presented results should prove helpful to clinicians and public health policy makers in improving screening, institutional infection control practices, and therapeutic delivery in resource constrained, endemic areas (Zafar et al., 2022).

2. Methods

A descriptive observational, cross-sectional study was conducted in a tertiary care institute in a well-established HCV endemic division of Pakistan. These methodologies were selected with the intent to depict an image of the demographic, behavioural, occupational and clinical characteristics of an ascertained HCV-positive group, through an examination of these interwoven factors at the same time in the intent to depict exposure situations and potential routes of transmission in the household, hospital and workplaces. The number of study participants (N=42) enrolled after the Genotype 3 positive group was confirmed by the pretreatment molecular study were, 32 males (76.2%) and 10 females (23.8%), a reflection of existing trends in the division and divided according to age groups 20, 30, 40 and 50 to assess the disease load in each category. The data were collected by structured questionnaire covering socio-demographic behavioural and clinical issues of life. The social and demographic issue includes age, sex and marital status (married or unmarried) whereas the nature of household was either nuclear or family or joint and family and occupational pattern for occupation, apart from health care and work as an agriculture worker and household work were individually taken into one of 18 occupational categories. Their behavioral history was documented through self-administered questionnaires listing tobacco use (smoker vs. non-smoker) and alcohol consumption (user vs. non-user). Liver condition was examined by Fibroscan (transient elastography) which is a liver stiffness measurement method identifying hepatic steatosis.

2.5 Statistical Analysis

Descriptive and cross-tabulation tools were used to outline the profile of the group. The analysis of categorical variables like age groups genders

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marital status, household structure, occupations, and substance use was done through counting and percentages. To find gender-related exposure, three times as many cross-tabulations were done. Pre-treatment test quantitative virological data was used to characterize the baseline inter-patient differences and to underpin the subsequent study of the early virological response dynamics.

3. Results

The 42-patient cohort study indicated a strong male dominance (76. 2% vs. 23. 8%). The age-based breakdown showed that the bulk of active infection was among mid-career adults: 52. 4% of the cases (n = 22) were from the 30-40 years group, while the 20-30 years group came second with 30. 9% (n = 13). The infection rates were very low at both age ends: the adolescent group (14-20 years) had only 4. 8% (n = 2) and the older adult group (40-50 years) was 11. 9% (n = 5).

Analysis of the data disaggregated by sex showed that males outnumbered females A lot across all age groups, mostly in 30–40-year age group (18 males vs. 4 females). A significant trend reversal occurred in the 40–50-year age group where females outnumbered males (4 vs. 1). Marital status information revealed that 76. 2% of patients (n = 32) were married (25 males, 7 females), which is in line with the main age profile of the group.

Table 1. Age and Sex Distribution of the HCV Genotype 3 Cohort (N = 42)

Age Group (Years)	Males (n)	Females (n)	Total (N)	Percentage (%)
14–20	2	0	2	4.8%
20–30	11	2	13	30.9%
30–40	18	4	22	52.4%
40–50	1	4	5	11.9%
Total	32	10	42	100.0%

Across 18 professional categories, a detailed occupational map showed several explicit concentration points. Farming accounted for the largest single group, 21. 4% of the entire cohort (n = 9), all males. Among females, a majority of them was domestic housewives at 14. 3% (n = 6). The biggest public health concern was the clustering of cases among healthcare workers: this sub-group alone constituted 19. 0% (n = 8) of all cases with 4 health workers (9. 5%), 3 ward boys (7. 1%), and 1 staff nurse (2. 4%). The other cases were scattered in labor (n = 3), housekeeping (n = 3), barbering (n = 2), and ten other vocational categories each providing a single case.

Table 2. Occupational Distribution of the Study Cohort (N = 42)

Occupation	Males (n)	Females (n)	Total (n)	Percentage (%)
Farmer	9	0	9	21.4%
Health Worker	4	0	4	9.5%
Housewife	0	6	6	14.3%
Ward Boy	3	0	3	7.1%
Labour	3	0	3	7.1%
Housekeeper	2	1	3	7.1%

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Occupation	Males (n)	Females (n)	Total (n)	Percentage (%)
Barber	2	0	2	4.8%
Student	1	1	2	4.8%
Staff Nurse	0	1	1	2.4%
Other (9 categories)	8	1	9	21.4%
Total	32	10	42	100.0%

Tobacco use was reported by 28.6% (n = 12) of the cohort, almost exclusively among males (11 males vs. 1 female), leaving a non-smoking majority of 71.4% (n = 30). Alcohol consumption was rare, recorded in only 4.8% (n = 2), both male; all 10 female subjects reported complete abstinence. Household structure analysis revealed that a clear majority — 66.7% (n = 28; 21 males, 7 females) — lived in joint-family arrangements, while 33.3% (n = 14; 11 males, 3 females) resided in nuclear-family setups.

Table 3. Behavioral and Household Characteristics by Sex (N = 42)

Variable	Males (n)	Females (n)	Total (n)	Percentage (%)
Smoker	11	1	12	28.6%
Non-Smoker	21	9	30	71.4%
Alcohol User	2	0	2	4.8%
Non-Alcohol User	30	10	40	95.2%
Joint Family	21	7	28	66.7%
Nuclear Family	11	3	14	33.3%

All 42 subjects (100%) were confirmed as HCV Genotype 3-positive on pre-treatment molecular evaluation. Fibroscan transient elastography demonstrated concurrent hepatic steatosis in 16 patients (38.1%), while the remaining 26 patients (61.9%) showed no detectable fibrotic or fatty changes at baseline.

4. Discussion

Overall, the majority of infected was among the males aged from 30-40 years (30-40, males: 76.2% of study population and 52.4% of the total number of patients in that group) (Almani et al., 2021). That means the routes of transmission seem to be directed by external structural and Occupational determinants not to mention that males who are more mobile, come in contact with workplace environment and used community shaving services more frequently than female (Babigumira et al., 2023). National and regional report of Pakistan data also shows the trend (Lotia-Farrukh et al., 2024). Big reports in premier medical journal indicate that high prevalence burden occurs among young males in endemic area of Punjab and Sindh (Alamneh et al., 2023). Thus the disease affects economically productive group and which increases the severity and impact on the community by virtue of being so and ages that leads to increase of disease prevalence according to year of exposure in the risk environment (Niyomsri et al., 2024). However, reversal trend found on age group 40-50 (female to male ratio 4:1) (Butt et al., 2022). Increase prevalence in the same group among women has clinical implication. Transfusion during pregnancy due to blood loss in obstetric emergency without good practice is thought to cause such infection (Ali et al., 2024). Also, women in that age group presented at a later age with either disease or

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when it was detected by testing. Because symptoms that appeared after decades suggest that these patients were infected long ago. This highlights the hidden, long-term burden of the disease (Qazi et al., 2021).

Agricultural workers were found at high risk of infection. In this study, 21.4% of the positive samples were from farmers. It could be due to Limited hospital access and low health literacy (Khan et al., 2022). Unfortunately, these practitioners often re-use needles and medical instruments. Unfortunately, these practitioners often re-use needles and medical instruments. exposure to unsterile equipment create a steady infection risk, keeping the regional epidemic alive (Shazi et al., 2023).

Healthcare workers face an exceptionally dangerous risk of transmission within local medical facilities. This study reveals that healthcare workers comprise 19.0% of the entire group, which represents eight individual cases from a single small sample (Khushdil et al., 2022).

Though tobacco does not spread the virus. Instead, household living arrangements serve as the primary behavioral risk variable. Nearly two-thirds of patients, or 66.7% of the cohort, live in joint family systems. Highly populated, multi-generational households facilitate the spread of the virus through non-sexual and non-medical routes that people rarely recognize (Javed et al., 2023). The shared use of personal care items introduces a constant risk of viral spread within large family units. Family members often share razors, nail clippers, and toothbrushes, which can let small amounts of blood enter tiny cuts in the skin (Yousafzai et al., 2022). This same risk factor is demonstrated in global medical literature whereby similar infections spread among households through shared utensils. In endemic zones, the house becomes a secondary source of infection, hence public health campaigns targeting household behavior are crucial in curbing the spread of the virus (Ver Hoeve et al., 2021).

With 76.2% of patients being married, the rate of transmission between partners becomes a major factor. This statistic is perhaps representative of the age of the population studied rather than any unusual risk related to marriage. Sexual transmission is much less efficient than blood transfusion, hence the risk of transmission between long-term partners will be relatively small (Waheed et al., 2022). Data suggests a low rate of transmission among stable monogamous couples and in fact partners of long-term relationships can carry low transmission rates. If one partner is affected, and the other has other problems or open sores, risk of transmission is significantly higher. In any patient with this condition, partner testing should be mandatory as part of standard care in order to halt transmission within families (Idrees et al., 2023).

All of the patients in this study carry Genotype 3 and though this finding is predictable for this region, the clinical implications are enormous (Ahmed et al., 2022). Fatty liver changes were seen in 38.1% of the patients on liver scan, a change which is normally associated with metabolic disorders in other genotypes of the virus. The viral infection itself induces these changes by inhibiting the activity of a lipidation-transporter protein and causing a subsequent accumulation of fat within the liver cells (Ismail et al., 2023). The liver pathology is not due to behavior on the part of the patient and requires urgent and aggressive management (Huang et al., 2024).

This cross-sectional study of patients with established Genotype 3 within the Pakistani population has highlighted multiple interconnected risk factors. The risk in working men in agriculture and healthcare clearly represents an occupational risk. The prevalence of fatty liver changes within this cohort, on the other hand, indicates a potentially aggressive viral strain. The family-based nature of the joint families and the relatively high rate of marriages indicate transmission within homes may be an important aspect of this epidemic which public health officials currently do not address. In relation to observational study, reference is made to the file "Research Methodologies", which contains both qualitative and evaluative frameworks for analyzing community-based health issues (Fan et al., 2024).

Effective public health strategies require targeted risk group specific approaches. This study demonstrates three key priority areas that demand immediate intervention: firstly, medical institutions require workplace-specific tracking and structured safety training for auxiliary personnel; secondly, regional health authorities

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need to promote low-cost community-based screening in joint families; thirdly, mandatory partner testing should become a mandatory rule. The impact of these interventions will translate to healthier personnel, rescued families and control of local epidemics (Asif et al., 2025).

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