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Editorial Note ●

We extend acknowledgement to our benevolent readers on the occasion of successful completion of "AMC JOURNAL (Dhangadhi)" "Research Publication of Research Management Cell (RMC)", Aishwarya Multiple Campus (AMC), Dhangadhi, Kailali. The RMC of Aishwarya Multiple Campus has completed the first issue of the year 2023, (Vol. 4). It serves the purpose of readers who are interested in contemporary knowledge of natural and social science.

Encouraging support of our benevolent readers, scholars, academicians, and members of advisory board inspired us to come up with this issue of the journal on time. It contains basically 7 articles. Among them 3 are related to natural science and remaining are related to social science. This journal gives priority to the research work or project work conducted by the teachers and the students of AMC. Its main aim is to inspire the research scholars, teachers and students of the campus to write something about what they do, feel, and observe. The research course has taken different modes like thesis writing, field work report, project work report, and term paper assignments as integral part of the teaching and learning procedure. Publication of these research-oriented activities in such type of journal encourages teachers as well as students in order to improve teaching and learning, and to enhance analytical and research skills.

We collected all articles from scholars of different fields and sent these articles for peer review work to related experts for their valuable suggestions, then we advised the writers to correct those articles. Finally, we again compiled all articles and edited them. This whole work was not possible without the sincere effort of the members of publication committee (Research Department), peer review team, editorial board, and advisory board. Long-time efforts and inspiration of these committees as well as benevolent creditors have made it possible to bring this issue into its present form. Therefore, we are always indebted to all learned scholars who have contributed their papers to publish this issue in time and valuable form. We also extend our gratitude to the advisory board and editorial board for their considerable assistance and sincere guidelines. We are further thankful to Prof. Dr. Hem Raj Pant, Prof. Dr. Chet Raj Bhatta, Prof Dr. M.L. Sharma Bhushal, Associate Prof. Dr. Mandev Bhatta and Dr. L.B. Thapa, for their sincere devotion to review articles of this issue. We are indebted to campus chief Mr. Dharma Dev Bhatta of AMC for his valuable support to publish this issue. We are also thankful to Mr. Kamal Prasad Bakhariya for this painstaking computer work.

Despite sincere efforts, the chance of human error cannot be avoided. Therefore, we would also like to take full responsibility of any kind of deficiency presented in the editorial aspect of this issue. Lastly, we expect creative comments and suggestions from learned scholars and readers for the forthcoming issue.

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STUDY OF SOME FUNGAL DISEASES OF TOMATO IN KATHMANDU VALLEY

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Abstract

Tomato plants were observed and collected the infected part from Jitpurphedi of Kathmandu, Nepal. These infected parts were kept in pathology lab for fungal isolation. The isolated fungus from the infected tomato plants were as *Septoria lycopersici*, *Cladosporium oxysporum* were responsible for leaf spot, *Phytophthora infestans* and *Rhizoctonia solani* were responsible for Leaf blight, *Cladosporium cladosporioides* was responsible for fruit rot, *Leveillula taurica* was responsible for powdery mildew and *Plasmopara viticola* was responsible for downey mildew disease. In the survey period, the highest incidence was found at leaf blight (30.08%) and lowest at stem rot (4.64%). In the case of severity, the maximum severity was found at Downey mildew (77%) and minimum was recorded at fruit rot (5.25%) on five different plastic houses.

Key words: *Lycopersicon esculentum*, Fungal diseases, Disease severity, Disease incidence

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.), flowering plant of the nightshade family (Solanaceae), cultivated extensively for its edible fruits. Labeled as a vegetable for nutritional purposes (Chapagain et al., 2011). Tomato is also known as the poor man's apple in Nepal with an average national consumption of 11.97 kg/person/year (Ghimire et al., 2017). It is cultivated in about 20,000 hectares (ha) in Nepal and around 0.3 million metric tons (MT) tomato is produced annually in the country (MoAD, 2014). There are around 7,500 tomato varieties grown for various purposes (FAOSTAT Database, 2012). Tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads, and drinks. Tomato is a good source of energy. Besides, carbohydrates, fats, proteins, vitamins, trace elements like magnesium, potassium, phosphorus, etc, and other constituents like water and lycopene are also present (USDA, 2009).

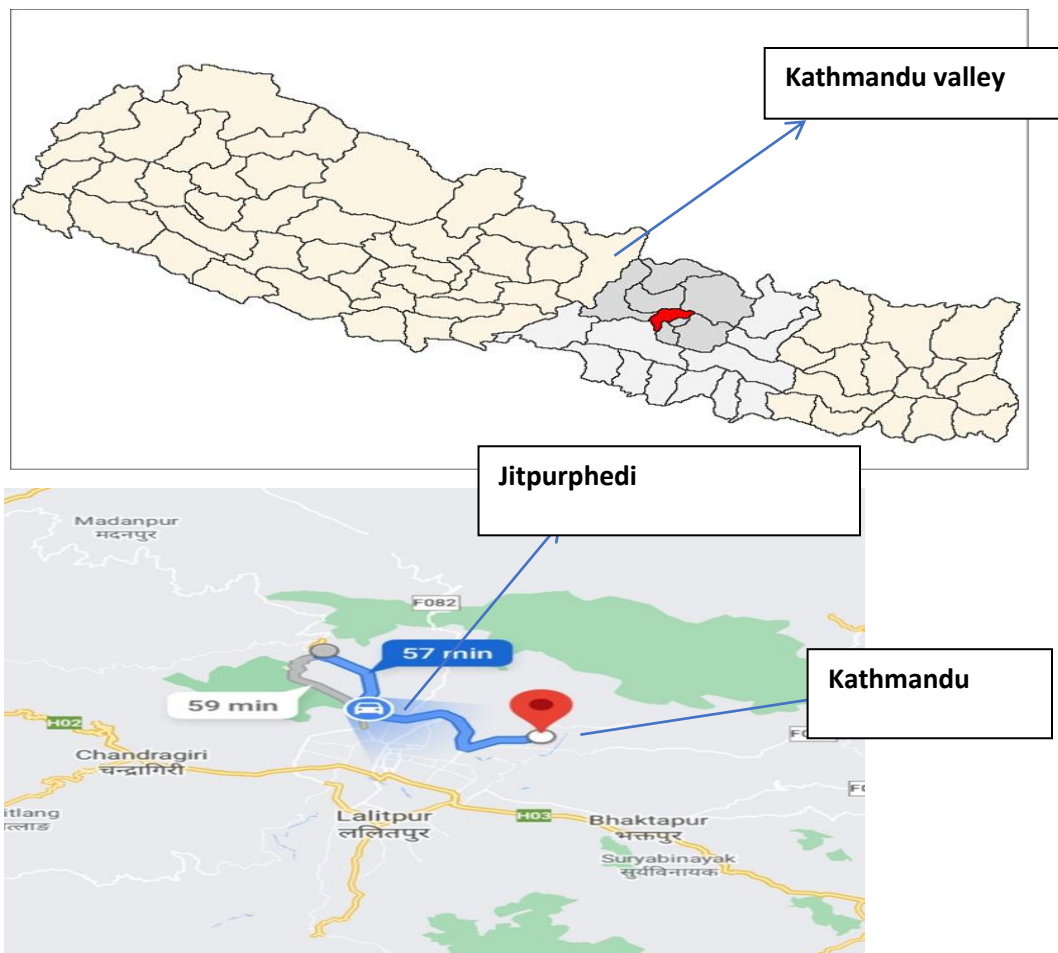
Tomatoes are affected by many fungal, Bacterial and pest pathogens. Fungi are an important group of microorganisms responsible for various diseases of plants and cause a considerable loss in yield (Kharde et al., 2010). Some species of fungus produce mycotoxins that are very toxic to humans. For e.g. Sphinganine- analog mycotoxins (SAM's) produced by *Fusarium moniliforme* of tomato inhibit de novo sphingo lipid (ceramide) biosynthesis in vitro, which leads to a variety of cellular responses, including accumulation of sphingoid bases in animal cells (Merrill et al., 1997). Tomato diseases caused by fungi includes leaf blights, leaf spots, mildews, rots of (root, stem, fruit), wilt diseases, etc, and cause severe damage to crops. Different groups of fungi like *Alternaria*, *Septoria*, *Phytophthora*, etc, are responsible to cause leaf disease. Disease on leaf causes degradation of photosynthetic area and loss of crop production. Species of *Fusarium* and *Verticillium* cause wilting disease. *Colletotrichum*, *Stemphylium*, etc. causes fruit rot diseases. Since 2010 more than 40 tomato diseases has been studied in Nepal. Report shows that disease in tomato is caused by infectious and non-infectious agents. It also reports that majority of disease causing agent is fungal pathogens infecting different plant parts (NARC 2010).

MATERIALS AND METHOD

Study Area

Fungal disease of tomato plants were collected from the Jitpurphedi of Kathmandu valley. Jitpurphedi is a village and former Village Development Committee that is now part of Tarakeshwar Municipality in Kathmandu District in Province No. 3 of central Nepal. It lies in 27.78°N 85.28°E coordinates.

Jitpurphedi, Agricultural farm is covered 20 Ropani of land area. Various vegetables were farmed along with tomato. Tomato plants were observed in five different tunnels inside the area to calculate disease incidence and severity as well as to collect the diseased parts of plants.



Collection of Diseased Plants Parts

During research period, the infected tomato plants (leaf, stem, fruits) were recorded and collected from Jitpurphedi of Kathmandu valley Nepal and fungus was isolated in pathology laboratory.

Visual observation was conducted in five different plastic houses in same location. Hundred plants of one plastic house were observed and recorded the number of infected parts of tomato plants.

Preparation of PDA Media

For preparing PDA media 100 gm of peeled potato was cut into small pieces and boiled for some time in 500 ml distilled water. The cooked potato pieces were filtered by muslin cloth, 20 gm dextrose was dissolved thoroughly and the volume of filtrate was maintained to 1000 ml by adding more water. Twenty gram of agar was added and stirred gently to get thoroughly mixed. The mouth of flask was covered with Aluminum foil and tied with sterilized rubber. And the media was autoclaved for 30 minutes in 121°C with 15 lbs pressure. Similarly, Water agar (WA) was prepared by mixing 20 gm agar with distilled water and final volume of mixture was made 1000 ml. These contents after mixing was sterilized in autoclave with 15 lbs pressure at 121°C for 15 minutes. Antibiotic was added after the media has cooled to 45-50°C

Isolation and Identification of the Test Fungus

Infected leaf, stem and fruit were collected from the plastic house in jitpurphedi of Kathmandu valley, by the help of sterilized needles and forceps some pieces of fungal colony from the infected parts of tomato plants was transferred aseptically on a Petri plate containing PDA media then it was incubated in inverted position in an incubator at 25±2°C for one week. After one week the growth of fungal colony were observed in petri plate and colony of the culture was observed under the compound microscope and studied the characteristics of the pathogen. The test fungus were identified with the help of standard literature and also by observing the features of macroscopic characters from the Stereo-Microscope at plant pathology lab of FRTC.

Maintenance of the Pure Culture

The pure culture of isolated fungi was preserved by sub-culturing in PDA media and incubated at 25±2°C. Similarly fungi were inoculated in agar slants and stored at <10°C for the preservation of their vigor and long term.

Preparation of One Week Old Culture

For testing the antifungal activity of the essential oils and extracts, inoculum disc from one week old culture is required. For preparation of one week culture, the fungus from pure culture was inoculated into PDA and after seven days the inoculum disc was taken from the culture for further experiment.

Pathogenicity Test

For carrying out the pathogenicity test, the infected leaves and fruits were collected and symptoms were noted down, then *plasmoparaviticola*, *Septoria lycopersici*, *Phytophthora infestans*, *Cladosporium sp*, *Leveillullataurica*, *Rhizoctonia solani*, *Chaetomium sp* was isolated in PDA media as pure culture. Inoculum from the pure culture was transferred to the healthy leaves and fruits. When incubated at 25±2°C for 7 days, the characteristics symptoms were produced, which were found to be similar with the symptoms on fruit and leaves previously collected. The fungus was isolated and its character was compared with the previously isolated fungus.

Measurement of Conidia Size

The size of conidia was measured by using optica software, computer and microscope in plant pathology lab of FRTC.

Measurement of Disease incidence

Disease incidences is simply the percentage of plant infected in a selected area which can be obtained by dividing the infected plants by total number of plants and multiply by 100.

$$\text{Disease incidence} = \frac{\text{Number of infected parts}}{\text{Total number of plants parts}} \times 100$$

Calculation of Disease Severity

The disease severity was expressed in PDI. The PDI was computed by using standard formula (Paper et al., 1996) is giving below

$$PDI = \frac{\sum (\text{Disease grade} \times \text{no. of plant in grade})}{\text{Total no. of plants} \times \text{highest disease grade}} \times 100$$

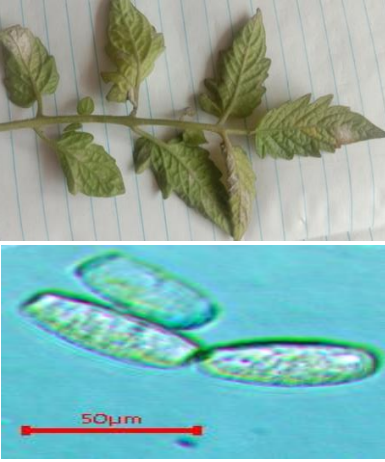


Result and Discussion

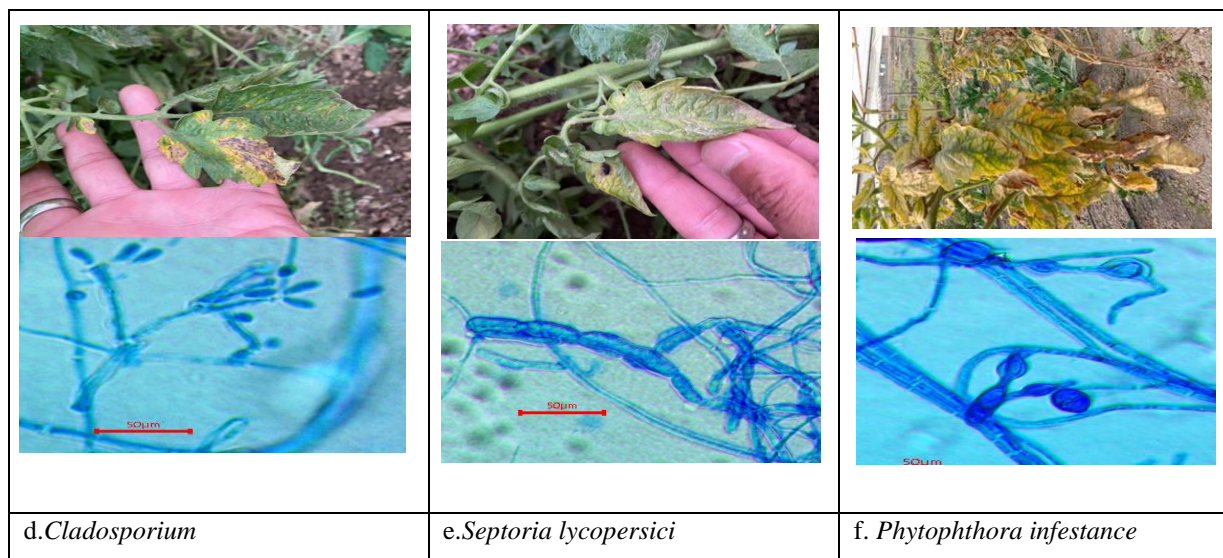
Survey and Identification of Fungal Pathogen

For observing the prevalence of disease incidence and severity of fungal disease in tomato plant, the disease was identified by symptomology of infected Tomato plants and compared with standard literature. It was found that there were six distinct symptoms prevalent at Jitpurphedi of Kathmandu valley. The seven different symptoms so far categorized are named as Leaf spot (LS), Leaf blight (LB), Downy mildew (DM), Powdery mildew (PM), Stem rot (SR), Fruit rot (FR). The development of black brown lesion on the young stem and leaf petioles as well as green ring spot developing on leaves was common and consistent with all the seven types of symptom. Yellowing of the leaf and distortion of fruits were observed in association with other symptoms.

Isolation of Test Pathogens

Seven fungal isolates were obtained from naturally occurring tomato leaves and fruits showing leaf blight (*Phytophthora* sp., *Rhizoctonia solani*) and leaf spot (in case of *Cladosporium oxysporum*., *Septoria lycopersici*.) *Plasmopara viticola* symptoms were found associated with *Septoria lycopersici* downy mildew disease. while *Phytophthora infestans*. and *Rhizoctonia solani*. were found associated with leaf blight. The pathogens were identified based on the morphological characteristics and articles (Barnett, 1960).

		
a. <i>Leveillulataurica</i>	b. <i>Rhizoctonia solani</i>	c. <i>Plasmopara viticola</i>



Incidence and Severity of Fungal Tomato Disease at Jitpurphedi in Kathmandu

Significant differences were found in disease incidence of six fungal pathogens at jitpurphedi in Kathmandu as shown in (Fig. 1). Disease incidence was calculated by visual observation part of tomato plant and applied on formula. The incidence ranged from 4.64% to 30.08% and the severity ranged from 5.25% to 77%.

Disease incidence were significant differences found among all six fungal pathogens. The highest disease incidence showed Leaf blight (30.08%) followed by Downy mildew (24.24%), Leaf spot (22.8%), Powdery mildew (5.24%) and the lowest incidence (4.64%) was found in stem rot.

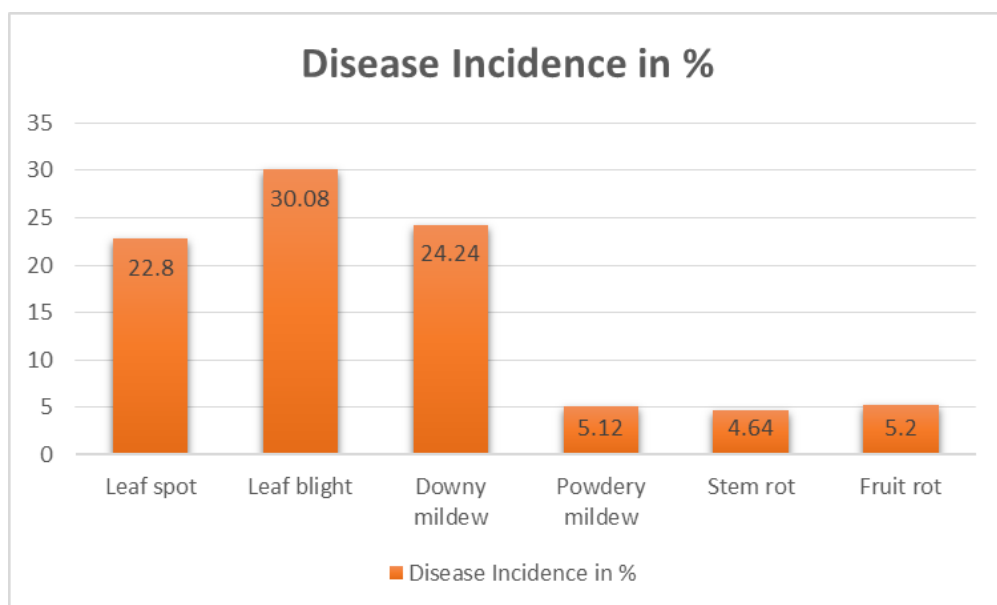


Fig. 1 Disease incidence of six different fungal pathogens

Disease Severity

Disease severity were Significant differences were found in among all six fungal disease in Jitpurphedi Kathmandu. The highest disease severity (77%) was in Downy mildew followed by (58%) leaf spot, Leaf blight (14.25%), Powdery mildew (9%), Stem rot (7%) and the lowest disease severity (5.25%) was found in fruit rot respectively.

Table1. Disease severity of six different fungal pathogens

SN		Disease grade	Disease severity %
1.	Disease severity of leaf blight	0	0
		25	3.5
		50	16
		75	14.25
		100	0
2.	Disease severity of leaf spot	0	0
		25	3
		50	17
		75	32.25
		100	58
3.	Disease severity of downy mildew	0	0
		25	4
		50	21.5
		75	39
		100	77
4.	Disease severity of powdery mildew	0	0
		25	0.5
		50	2.5
		75	5.25
		100	9
5.	Disease severity of stem rot	0	0
		25	0.25
		50	1.5
		75	3.75
		100	7
6.	Disease severity of fruit rot	0	0
		25	0.5
		50	2.5
		75	5.25
		100	3

CONCLUSION

Tomato (*Lycopersicon esculentum*) production was decrease due to many fungal, bacterial, viral pathogens as well as by nematodes. Tomato is a very important vegetable all over the world and though its demand is increasing day by day, the production of tomato is not satisfactory. The present experiment was designed to study the surveillance and identification of fungal disease based on symptomology and to observe the disease incidence and severity of fungi at Jitpurphedi Kathmandu Nepal. In the survey period, the highest incidence was found at leaf blight (30.08%) and lowest at stem rot (4.64%). In the case of severity, the maximum severity was found at Downey mildew (77%) and minimum was recorded at fruit rot (5.25%).

Six fungal pathogens were identified and pathogenicity test of two fungi were done. The identified fungi were Leaf spot (*Septoria lycopersici* and *cladosporiumcladosporioides*), leaf blight (*Rhizoctonia solani* and *Phytophthora infestans*), Downey mildew (*Plasmopara viticola*), powdery mildew (*Leveillula taurica*).

Acknowledgement

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An Ecological Assessment of Invasive Alien Plant Species in Jokhar Lake Area of Kailali District, Nepal

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Abstract

Invasive alien plant species (IAPS) have been creating adverse impacts on native diversity. Diversity of Nepal's wetland ecosystems are also threatened by several IAPS but the related studies are very scarce. This study has assessed the status of IAPS found in Jokhar Lake of Kailali district, Nepal. The IAPS survey was carried out by sampling 30 plots of (1×1)m² each in and around the lake area. A total of 17 species of IAPS were reported from the study site. Most of the IAPS were the members of the family Asteraceae. The diversity of IAPS in the lake represents about 65% of the total IAPS in Nepal. Around the lake periphery, *Ageratum houstonianum* and *Argemone mexicana* and inside the lake *Eichornia crassipes* and *Pistia stratiotes* were major IAPS. The natural beauty of the lake has been ruined by these IAPS. A detailed study on the impacts and ecology of these IAPS in the lake and lake periphery is still lacking. Hence, it is recommended that the IAPS in the lake area should be controlled to conserve the native diversity and the natural beauty of the lake.

Keywords: Jokhar Lake, alien plants, invasion, native diversity, conservation

Introduction

Some of the plant species native to one area or region after introduction into the novel area outside their normal distribution might become problematic for native diversity, ecosystem functioning, and for the livelihood of community people. Such species are termed as the invasive alien plant species (CBD 2009). Generally, the species which show such characteristics display strong vegetative growth, grow in even adverse soil and climatic conditions, and can produce a large number of minute or long-lived seeds (Lee et al. 2018; Mathakutha et al. 2019). They also have a high seed germination rate, rapid maturation of a sexually reproductive stage, and high ability to establish over large areas (Forman and Kesseli 2003; Whitney et al. 2008).

The IAPS may be herbs, shrubs, trees, and vines that can grow rapidly, form dense thickets, and negatively impact native species and natural communities (Walker and Smith 1997; Zenni and Ziller 2011; Barney et al. 2015). Anthropogenic disturbances, increasing human movement, global trade, and climate change have increased the intensity of biological invasion worldwide (Lin et al. 2007; Masters and Norgrove 2010; Beauséjour et al. 2015).

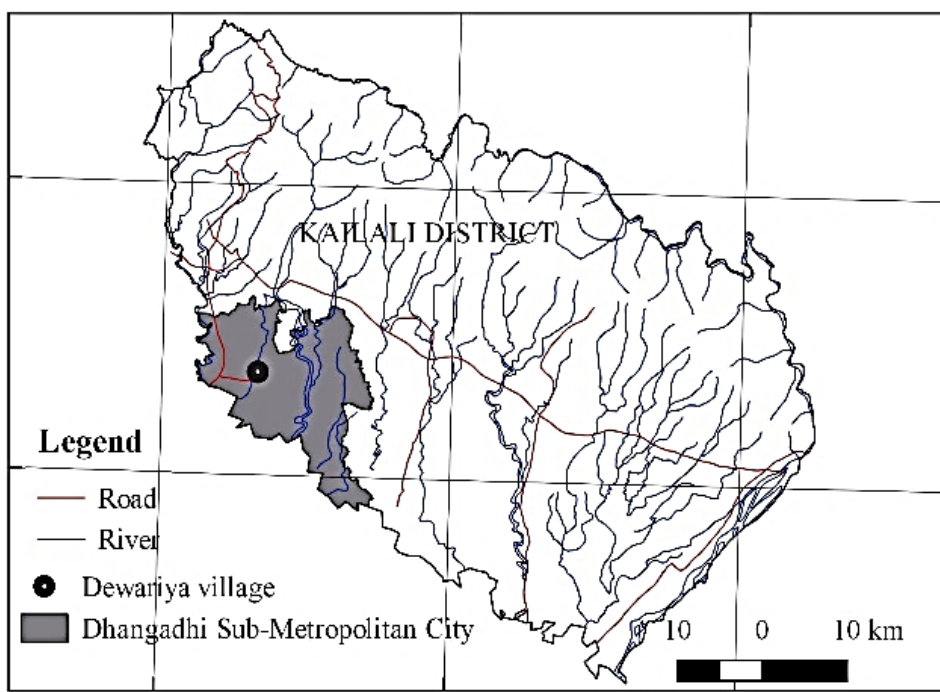
A wide variation of climate and geography of Nepal has favored the introduction of several alien plant species in the country. There are 26 alien plant species categorized as invasive members in Nepal (Shrestha et al. 2016). Among these, *Lantana camara*, *Mikania micrantha*, *Chromolaena odorata*, and *Eichornia crassipes* are among the 100 of the world's worst invasive alien species (Lowe et al. 2000). They have been widely distributed throughout the country. Mainly the degraded lands, roadsides, forest margins, and other degraded habitats are the main target of invasion where the IAPS has been creating adverse impacts on native diversity (Tiwari et al. 2005; Shrestha 2016; Thapa et al. 2015, 2016a, 2016b, 2017). Besides, Nepal is also rich in wetlands and wetland diversity but alien plant invasion in such ecosystems has also threatened several native flora and fauna (Shrestha et al. 2020; Thapa et al. 2020a, 2020b). In this situation, activities regarding the regular monitoring of IAPS, assessing their impacts on native diversity, and control or management of IAPS is an urgent need. The main of the study is to assess some of the basic ecological parameters of IAPS found in Jokhar Lake of Kailali district.

Material and Methods

Study site

This study was carried out in Jokhar Lake area (28°42'24.23" N and 80°37'21.02"E) near the Dewariya village located in Dhangadhi Sub-Metropolitan City – 7 (Fig. 1). The lake is a famous wetland of Sudurpaschim Province, Nepal which is situated about 5km far from the main city Dhangadhi. The lake area covers about 120 ha. It also has religious significance in the Tharu community. The vegetation around the Jokhar Tal is dominated by mainly Sal tree (*Shorea robusta*), *Bombax ceiba*, *Acacia catechu*, *Terminalia alata*, *Syzygium cumini*, and *Dalbergia sissoo*. The climatic of the study site is hot in the summer season (above 38°C) and cold in winter (7.5°C). The rainfall is maximum in July (693.4mm) and minimum in November (2.5mm). The relative humidity remains fairly throughout the year except in dry months. The lake was severely colonized by aquatic invasive *Eichhornia crassipes*. The surrounding of the lake was also invaded by a number of IAPS.

Fig. 2. Map of study site showing Dewariya village and Dhangadhi Sub-Metropolitan City in Kailali District



Survey on IAPS

The IAPS survey was carried out during September-October 2018. The IAPS richness, density, frequency, and abundance were measured around the lake by sampling plots of size 1×1 m² (as most of the species were herbaceous). A total of 30 quadrats were sampled along the margin of the lake and among them alternately 15 were sampled in water and 15 were out of the water (Fig. 2). In these quadrats the IAPS encountered were recorded. Their density, frequency, abundance, and IVI were calculated. Voucher specimens were collected, identified and herbaria have been deposited at Department of Botany, Kailali Multiple Campus, Dhangadhi, Kailali. Copies of voucher specimens are preserved at Tribhuvan University Central Herbarium (TUCH), Kirtipur, Kathmandu, Nepal.

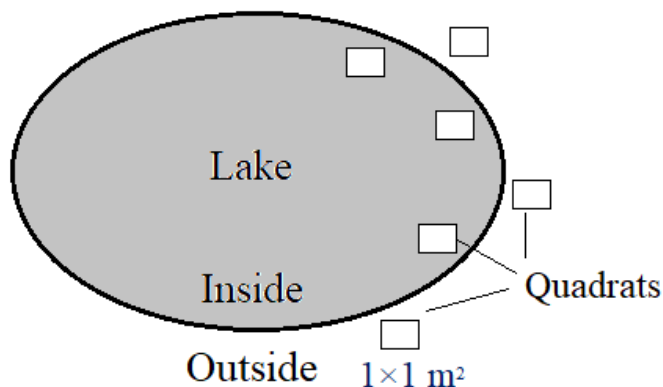


Fig. 2 Arrangement of quadrats in the study site

The density, relative density, frequency, relative frequency, abundance, relative abundance, and important value index (IVI) of the IAPS were calculated using the following formulae:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Relative Density} = \frac{\text{Number of individuals of one species}}{\text{Total number of all individuals counted}} \times 100$$

$$\text{Frequency} = \frac{\text{Number of quadrats in which the species occurs}}{\text{Total number of quadrats sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of one species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Abundance} = \frac{\text{Total Number of individuals of a species in all quadrats}}{\text{Total number of quadrats in which the species occurred}}$$

$$\text{Relative Abundance} = \frac{\text{The abundance of one species}}{\text{Total all species counted}} \times 100$$

$$\text{Importance Value Index (IVI)} = \text{Relative Frequency} + \text{Relative Density} + \text{Relative Abundance}$$

Results

IAPS in the Jokhar Lake area

The study reported a total of 17 species in and around the Jokhar Lake area (**Table 1**). Most of the species (6 species) were the members of the family Asteraceae. They were *Ageratum houstonianum*, *A. conyzoides*, *Bidens pilosa*, *Xanthium stramonium*, *Parthenium hysterophorus*, and *A. adenophora*. Two species *Alternanthera philoxeroides* and *Amaranthus spinosus* were the members of the family Amaranthaceae. The rest of the species represented a single-family. They were *Pistia stratiotes* (Araceae), *Senna tora* (Fabaceae), *Ipomoea carnea* (Convolvulaceae), *Hyptis suaveolens* (Lamiaceae), *Mimosa pudica* (Mimosaceae), *Oxalis latifolia* (Oxalidaceae), *Argemone mexicana* (Papaveraceae), *Eichhornia crassipes* (Pontederiaceae), and *Lantana camara* (Verbenaceae). Among them, *E. crassipes* (Pontederiaceae) and *P. stratiotes* (Araceae) were aquatic species found in the water body.

Table 1. List of IAPS found in Jokhar Lake, Kailali

SN	Family	No of species	Name of species
1	Asteraceae	6	<i>Ageratum houstonianum</i> , <i>A. conyzoides</i> , <i>Bidens pilosa</i> , <i>Xanthium strumarium</i> , <i>Parthenium hysterophorus</i> , and <i>A. adenophora</i>
2	Amranthaceae	2	<i>Alternanthera philoxeroides</i> and <i>Amaranthus spinosus</i>
3	Araceae	1	<i>Pistia stratiotes</i>
4	Fabaceae	1	<i>Senna tora</i>
5	Convolvulaceae	1	<i>Ipomoea carnea</i>
6	Lamiaceae	1	<i>Hyptis suaveolens</i>
7	Mimosaceae	1	<i>Mimosa pudica</i>
8	Oxalidaceae	1	<i>Oxalis latifolia</i>
9	Papaveracea	1	<i>Argemone mexicana</i>
10	Pontederiaceae	1	<i>Eichhornia crassipes</i>
11	Verbenaceae	1	<i>Lantana camara</i>
Total species		17	

Density, Frequency, Abundance, and IVI of IAPS

Among the 17 IAPS reported from Jokhar Lake, the most dominant two species were *A. houstonianum* and *A. mexicana*. Relative density (RD), relative frequency (RF), and relative abundance (RA) of *A. houstonianum* were 45.30, 14.14, and 1.74, respectively followed by *A. mexicana* (RD = 16.05, RF = 9.24 and RA = 0.94). The highest IVI was calculated in *A. houstonianum* i.e. 61.18 followed by 26.23 in *A. mexicana*. *Ageratina adenophora* has the lowest RD (0.35) and IVI (2.10). The lowest frequency was found in *Pistia stratiotes* (1.63) and *A. adenophora* (1.63). RD, RF, RA, and IVI of all the 17 species have been given in **Table 2**.

Table 2. Ecological parameters of IAPS in Jokhar Lake, Kailali

SN	Scientific Name	Relative Density (RD)	Relative frequency (RF)	Relative abundance (RA)	Important value index (IVI)
1	<i>Ageratum houstonianum</i>	45.30	14.14	1.74	61.18
2	<i>Argemone Mexicana</i>	16.05	9.24	0.94	26.23
3	<i>Lantana camara</i>	4.79	3.26	0.80	8.85
4	<i>Alternanthera philoxeroides</i>	4.70	5.98	0.43	11.11
5	<i>Senna tora</i>	4.43	4.89	0.49	9.82
6	<i>Oxalis latifolia</i>	3.46	8.16	0.23	11.84
7	<i>Bidens pilosa</i>	2.30	8.16	0.15	10.62

SN	Scientific Name	Relative Density (RD)	Relative frequency (RF)	Relative abundance (RA)	Important value index (IVI)
8	<i>Xanthium strumarium</i>	2.75	8.16	0.18	11.09
9	<i>Eichhornia crassipes</i>	3.46	4.89	0.38	8.74
10	<i>Ipomoea carnea</i>	3.72	6.53	0.31	10.56
11	<i>Parthenium hysterophorus</i>	2.04	2.72	0.41	5.17
12	<i>Ageratum conyzoides</i>	2.22	5.98	0.20	8.40
13	<i>Hyptis suaveolens</i>	0.53	8.16	0.04	8.72
14	<i>Pistia stratiotes</i>	1.68	1.63	0.56	3.88
15	<i>Amaranthus spinosus</i>	1.68	3.26	0.28	5.23
16	<i>Mimosa pudica</i>	0.53	3.26	0.09	3.88
17	<i>Ageratina adenophora</i>	0.35	1.63	0.12	2.10

Discussion

Jokhar Lake is one of the important wetlands of Far Western Province, Nepal situated in Dhangadhi Sub-Metropolitan City –7, Kailali. It is categorized as a freshwater/natural; lacustrine and permanent wetland (DoF 2017). The lake is the habitat of several plants and animals. Major aquatic plants found in the lake include *Ludwigia adscendens*, *Utricularia Australia*, *Oryza rufipogon*, *Sphagnum nepalensis* and the major plant species found around the lake are *Shorea robusta*, *Syzygium cumini*, *Adina cordifolia*, *Acacia catechu*, *Dalbergia sisoo*, *Ctenopharyngodon idella*, etc. (DoF 2017). The lake has also a religious significance among the Tharu community. It is also one of the visiting destinations of tourists and provides spots for picnic. Therefore, invasion of alien plant species in and around the lake has been taken place but regular monitoring of IAPS and ecological assessments on them was lacking.

This study has documented a total of 17 IAPS in and around the Jokhar Lake area (Table 1). Six species were the members of family Asteraceae (*Ageratum houstonianum*, *A. conyzoides*, *Bidens pilosa*, *Xanthium strumarium*, *Parthenium hysterophorus*, and *A. adenophora*), two species (*Alternanthera philoxeroides* and *Amaranthus spinosus*) were Amaranthaceae. The families Araceae, Fabaceae, Convolvulaceae, Lamiaceae, Mimosaceae, Oxalidaceae, Papaveraceae, Pontederiaceae, and Verbenaceae had single members each (Table 1). In Nepal, 26 species were categorized as the problematic IAPS (Shrestha 2016). The number of IAPS in the Jokhar Lake area represents about 65% of total IAPS in Nepal.

Around the lake periphery, *A. houstonianum* and *Argemone mexicana* had high relative density (RD) and relative frequency (RF). The IVI of *A. houstonianum* was also the highest among all IAPS (Table 2). Two aquatic IAPS in the lake were *E. crassipes* and *P. stratiotes*. These two species were highly problematic in the lake as they have covered major parts of the lakes (personal observation). *E. crassipes* is included in the list of the world's 100 worst IAPS (Lowe et al. 2000).

All the members of IAPS reported from the lake has several ecological impacts. For example, *A. houstonianum*, *A. conyzoids*, *B. pilosa*, *P. hysterophorus*, *A. adenophora* replace native plants and alter soil quality (Kohli et al. 2006; Cui and He 2009; Timilsina et al. 2011; Thapa et al. 2017; Shrestha et al. 2018). Another worst aquatic *E. crassipes* and *P. stratiotes* are also known to cause significant ecological and socio-economic effects. They can

affect negatively the phytoplanktons, zooplanktons, macroinvertebrates, fishes, birds, etc. (Villamagna and Murphy 2010). Both the species can rapidly form dense mats on the water surface which have serious negative effects on the multifunctional human use of water bodies (Cabi 2019). Both the species also have the ability to change physiochemical and biological characteristics of water bodies (Cabi 2019).

Invasion of IAPS around and inside the lake might have created severe environmental problems such as several native species might have replaced, seedling recruitment of native species might have affected negatively, soil and water quality of the lake, as well as the aquatic flora and fauna, might have changed. Overall, the natural beauty of the lake has been destroying by these IAPS. A detailed study on the impacts of IAPS in the lake and lake periphery is still lacking. Hence, it is recommended that the IAPS in the lake area should be controlled to conserve the natural beauty of the lake.

Conclusion

In conclusion, a total of 17 species of IAPS have invaded in and around the Jokhar Lake of Kailali district, Nepal. Most of the IAPS were the members of the family Asteraceae. The diversity of IAPS in the lake represents about 65% of the total IAPS in Nepal. Around the lake periphery, *A. houstonianum* and *Argemone mexicana* and inside the lake *Eichornia crassipes* and *Pistia stratiotes* were major IAPS. The natural beauty of the lake has been corrupted by these IAPS. A detailed study on the impacts of these IAPS in the lake and lake periphery is still lacking. Hence, it is recommended that the IAPS in the lake area should be controlled to conserve the native biodiversity and the natural beauty of the lake.

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Causes and Consequences of Teenage Marriage Among Dalit Teenagers

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Abstract

The study seeks to identify the different causes and its consequences women's health. The study is based on quantitative research design. To achieve the devised objectives of the study, the researcher has selected 90 respondents from Barbardiya Municipality using purposive sampling method. The data was collected from primary source. The only tool for collecting data was semi structured interview schedule. The collected data was coded, edited and proceed manually. Number and percent were major statistics measures used in analyzing and interpreting the data. Out of 90 respondents i.e. sample population 61.11 percent respondents are illiterate. It is also found that 64.66 percent respondents got married between the ages of 15-19 years. 60 percent women became pregnant within one year after the marriage. Likewise, 19.33 percent respondent did not checkup their health during pregnancy. Most of the respondents have involved in agriculture. 58.88 percent respondents belong to joint family. The most of respondents, 66.66 percent got teenage marriage because of their parent's decision. Most of the respondents have knowledge about family planning devices. 38.88 percent respondents used family planning devices. In this study area, most of respondents (45%) have more than two children. Likewise, 68.81 percent respondents suffered from miscarriage due to teen age marriage. 82.22 percent respondents' place of delivery was at home. In conclusion, it was found that the main cause of early marriage has lack of education, tradition, socio-economic condition, poverty

Key Words: Dalit women, cause, impact, teenage marriage

Introduction

Teenage marriage can have several harmful effects on the overall wellbeing of a girl child who is not mentally, psychologically emotionally and physically prepared for marital life it's determined by culture education status social character love enjoyment and discrimination etc. The consequences of teenage marriage which results low education unwanted pregnant, unsafe abortion. Teenage marriage increase population maternal and child mortality rate because when a girl was have the probability of bearing more children. Mother and her children many kinds of health problems. Teenage marriage is a global issue, which is prevalent stay every where it after the girls reproductive health and wellbeing of people. Teenage marriage can have several harmful effect on the overall wellbeing of a girl child who is not mentally, psychologically, emotionally and physical prepared for a marital life and early marriage runs has of opportunity of starting or continuing education and deprives personality developments and rules like a good wife, perfect daughter in law and a responsible mother. The most important factors of early marriage are religious beliefs and practice of premarital sex, parents are willing to marry than children at an early age which is one of the most sensitive issue in Nepal where virginity is given high social value the female marriage age is found to have younger. Nepal has patriarchal society and female virginity is valued highly which a prerequisite for marriage too. This is one of the reasons for teenage marriage of Nepal.

Barbardiya Municipality of Bardiya district is one of the municipalities where there is still practice of teenage marriage. The most of the Dalit people of Barbardiya Municipality are illiterate. Due to their traditional belief, superstition and cultural barrier, they often get teenage marriage. It proves that there is strong need to conduct a study on such teenage marriage practices in Barbardiya Municipality. So the researcher has selected the topic 'Causes and Consequences of Teenage Marriage among Dalit Teenagers in Barbardiya Municipality Bardiya District'.

Objectives of the Study

The main objective of the study is to identify the causes and consequences of teenage marriage among Dalit teenagers in Barbardiya Municipality of Bardiya district. The specific objectives of the study were as below:

- to assess their knowledge on the effects of teenage marriage
- to find out the causes of teenage marriage.
- to identify the consequences of teenage marriage.

Review of Literature

Hammond and et al. (1995) studies 'Religious heritage and teenage marriage' stated that teenage marriage may be a ways of legitimately culminating a sexual relationship and attaining adults states. Our purpose is to investigate whether the religious in which a young person was raised has an impact on the decision it marry early extrapolating from our findings on premarital research of other. We hypothesized that fundamentalist and institutional sector produce higher rates of teenage marriage.

Santow (1997) women's inferior social status in many societies causes women to have and inferior nutritional status resulting from consuming less too, than men. This situation is particularly severe for young adult women who may have elevated nutritional requirements because they are pregnant or location. status issue also increase the risk of child bearing women in many developing countries are under pressure to produce large families efforts to improve women's health situation include improving female education and researcher are beginning to delineate the role of men and extended family members in improving infant and child mortality.

CBS (1997) state that increasing age at marriage was having a depressing effect on number of younger women who are exposed to pregnancy. It was to pregnancy. It was noticed that there has been an increase in female age at marriage from 15.4 to 18.1 between 1961 and 1991 in Nepal. This has apparently been achieved mainly due to the tendency of younger persons to post phone marriage there may be combination factors and contributing to this expansion of literacy education and health services, development of other section such as transport and communication are the increasing urbanization and the fixation of the legal minimum age at marriage according to the national act of 1955, the legal minimum age at marriage is in Nepal is 18 years of for female without consent and 16 with consent of parent.

United Nation (UN,, 2006) Reported on 'World marriage pattern' show that early marriage result into early pregnancy. pregnant women younger than 15 years are four times more likely to die during pregnancy and child birth. It results in adequate growth under nutrition hypertension and anaemia. Mother hood imposed on an immature body can result in prolonged and obstructed labour and lifelong health problems. Adolescent women married too much older men are unable to communicate negotiable the timing and frequency of intercourse and wife therefore unable to control their own fertility.

UNICEF (2006) report on 'early marriage harmful Traditional practices A statistical exploration' has shown that globally 36 percent of women aged 20-24 were married or in union before they each 18 years of age an estimated 14 million adolescent between 15 and 19 give birth each year's girls the age group are twice as likely to die during pregnancy or child birth as women in their twenties marriage of young girl is most common in sub-Saharan. Africa and south Asia in Niger, 77 percent off 20-24 year old women were married before the age of 18. In Bangladesh this rate was 65 percent.

Ghimire (2005) conducted astudy on ' Effects of early marriage on women health in Damain community of Bhorletar VDC Lamjung ' with the objective to find the cause of early marriage. He used descriptive research design and purposive random sampling method for determining the sample for the study found that the cause of early marriage is the practice or traditional value which is 76.67 percent among total Damain women have assess

o health facilities during pregnancy. Among all 73.33 percent women were illiterate. His study concluding that the main cause of early marriage is the proactive of traditional value norms and religion in Damain community. Achaya (2008) conducted his study on 'determinant of teenage marriage and its effect on mother and child health in Jukena VDC of Arghakhachi district. 'with the objective to found out the determinant actors of teenage marriage and its effect on health of child and mother. His study revealed in below 15 years. Similarly, 67 percent respondents did not have any knowledge about early marriage. His study also showed that 71 percent of the girls got pregnant for this first time between the age of 15-19 years. The monthly income of the 43 percent of the respondent in below 10 thousand per month.

Methodology

This study employ quantitative research designs. The study mainly focused on cause and consequences of teenage marriage among Dalit Teenagers. The study is based on primary data which was collected through semi-structured schedule.

The population of the research consists of all the Dalit women of Barbardiya Municipality of Bardiya District who are under the age of 25 and got married in teenage period. Thus, the population of the study area is 568 household women (Municipality profile of Barbardiya Municipality, 2075) who got married below 19 years. The sample population consisted of 90 married teenaged Dalit (8 women from 1-10 number wards and 10 women from 11 number wards) women of Barbardiya Municipality. Sample unit for the study was obtained using purposive sampling method.

The tool for this study was semi structured interview schedule. To collect necessary information, 35 questions were incorporated for the respondents. Both open and closed ended questions were included in semi structured interview schedule. Semi interview schedule was constructed on the basis of causes and consequences of teenage marriage among Dalit teenagers

Collected data was presented in different table and groups. After the collection of information, data were checked, verified at the field manually to reduce it error. The final data was tabulated and interpreted by using the tables, simple and simple statistics.

Result and Discussion

Knowledge about Teenage Marriage

The respondents were asked whether they had familiar with the term teenage marriage or not. Most of the respondents were unknown about it.

Table No. 1

Knowledge about Teenage Marriage

Response	No of Respondents	%
Yes	80	88.89
No	10	11.11

The above data shows that out of 90 respondents, 80 respondents were unknown about teenage marriage. Only 11.11 percent i.e. 10 respondents were familiar with teen age marriage.

Knowledge Regarding the Merits and Demerits of Teenage Marriage

Teenage marriage may have some *merits* and demerits. The view of respondents is given in the following table

Table No. 2

Familiarity on merits and demerits of teenage marriage

Yes	Percent	No	percent	Don't know	Percent
35	38.89	45	50	10	11.11

The respondents were asked if there are any advantages and disadvantages of teenage marriage . 38.89 percent of the respondents remarked the advantages of teen age marriage , 50 percent of the respondents told the it doesn't have any advantages and 11.11 percent of the sample population were not sure whether it has benefit or demerits.

Benefits of Teenage Marriage

According to respondents, teenage marriage has some advantages as well. Their views are presented below

Table No. 3

Advantages of teenage marriage

Benefits	No of Respondents	Percent
Ease to rare child	35	38.88
Romance in time	5	5.57
No feeling of responsibility	15	16.57
Getting support in the early life from the children	25	27.77
Getting help from the family members	10	11.11
Total	90	100

The above table clearly shows that among 90 participants 38.88 percent respondents told that if we got teenage marriage it is easy to rare the children. Similarly 5.57 percent respondents viewed that teenage marriage is beneficial to get romance in time. 27.77 percent respondents were in favour of teenage marriage because of getting support in the early life from their sons and daughters. And 11.11 percent sample population viewed that to get help from the family members it is beneficial

Perception of Society on Teenage Marriage

The view of respondents regarding the perception of society on teenage marriage is given below.

Table No. 4

View of society on teenage marriage

Good	percent	Bad	percent	Don't know	percent
13	4.44	67	4.44	10	11.11

The researcher asked how is the teenage marriage viewed in the society.14.44 percent viewed good, 74.44 percent viewed bad and 11.11 percent didn't have replied we don't know.

Satisfaction due to Teenage Marriage

Normally we are not satisfied in teenage marriage . Their satisfactions and dissatisfaction in teenage marriage is given below.

Table No. 5

Satisfaction in teenage marriage

<i>3</i>	<i>No of respondents</i>	<i>Percent</i>
Yes	26	28.89
No	64	71.11
Total	90	100

The data above clearly shows that most of the participants 71.11 percent were not satisfied of teenage marriage and only 28.89 percent were satisfied.

Prominent Health Problems due to Teenage Marriage

Teenage marriage may create serious health problem on both child and mother. The view of the respondents regarding this is given below.

Table No. 6

Health problem due to teenage marriage

<i>Responses</i>	<i>No of Participants</i>	<i>Percent</i>
Miscarriage	9	10
Child's death	55	61.11
Mothers death	26	28.89

Miscarriage, child's death and mother's death are the major health problem due to teenage marriage. According to 10 percent of the respondents miscarriage is the main problem, for 61.11 percentage child's death and for 28.89 percent mother's death is the major health problem due to teenage marriage.

Causes of Teenage Marriage

Teenage marriage is a common problems in our society. According to the recent survey to percent of girl aged 16 get married. So, it is necessary to analyze and find out the causes of teenage marriage. Some of the cause are immature love affairs, social norm, traditional causes and poverty. These factors are responsible for the teenage marriages in teenage marriage in Dalit communities are percent in the table.

Table No. 7

Causes of teenage marriage

<i>Causes</i>	<i>No. of respondents</i>	<i>Percent</i>
Love	23	25.55
Social causes	4	4.44

Causes	No. of respondents	Percent
Traditional cause	55	61.11
Poverty	8	8.88
Total	90	100

Which account 25.55 percent much alike traditional. Causes and love attain, poverty was another factor that obliged Dalit respondents to get married in the teenage. The data reveals that 8.88 percent were married due to the poverty. It is evident that any few 4.44 percent were married due to social causes.

The major causes of teenage marriage in Dalit community were traditional causes and traditional norms and value prevalent in this society..

Economic Causes of Teenage Marriage

Teenage marriage is affected by economic condition people of middle class can manage basic needs for their son/daughter but people of lower classes cannot manage and fulfil their needs. As a result get teenage marriage economic cause of teenage marriage in Dalit community are presented in Figure 1.

Figure No.1

Economic causes of teenage marriage

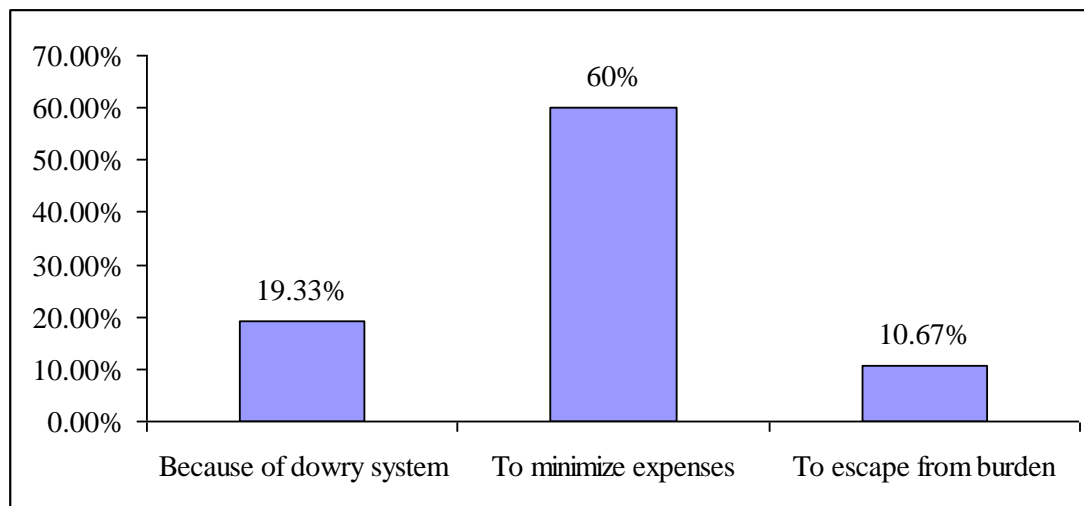


Figure 4 shows that 60 percent respondents causes of teenage marriage was to minimize family expance because most of the Dalit respondents tall under the joint family and more family members increase cost of living. So they in teenage age decide to many their children. In the some way 19.33 percent respondents got married before that age of 19 because of dowry system. In addition to there 10.67 percent respondent got married before age of 19 to escape from further burden.

The most of the respondents of Dalit community get married in order to minimize the second majority of the respondents got married in teenage because of dowry system and the least of the respondents got married in order to escape from further burdens.

Consequences of Teenage Marriage

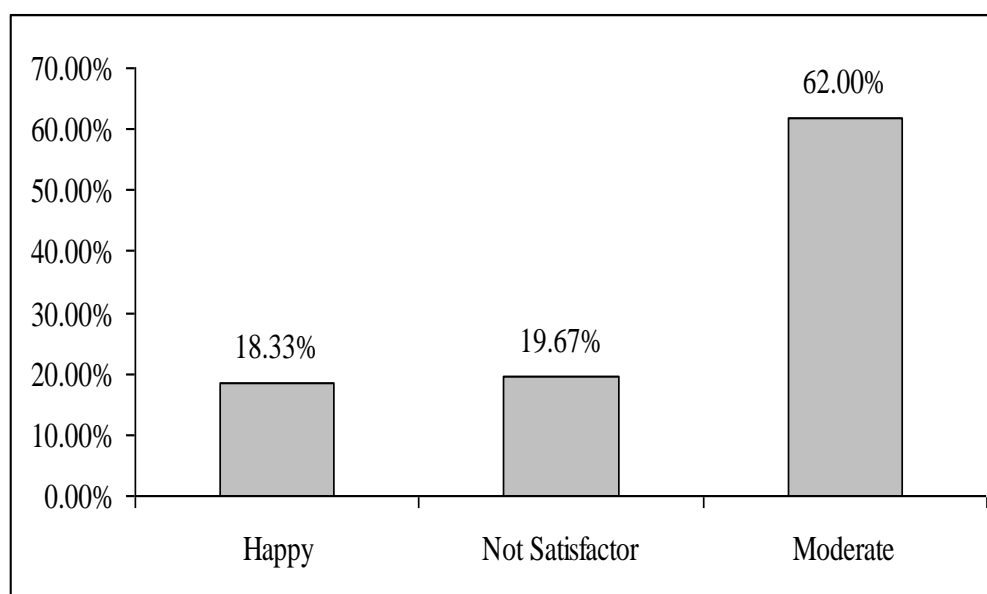
Teenage marriage levees its everlasting effect on the health of women. When the girls below the age of 20 are married get pregnant and forced to bear a child. Certainly her health is affected by it since her overall physical development is not possible in such age on the other hand early marriage contributes in increase of population, which may be problematic for poor familiar. Not only those, there is the high risk of miscarriage, stillbirth too the consequences of teenage marriage is presented in different subtopic herewith.

Feeling after Marriage

Who have get married in teenage after that is their felling? (Like as somebody feel happy, somebody feel moderate and somebody feel sad? Their feelings are different. In this study they were asked about the taking of often marriage which is shown in figure 2.

Figure No. 2

Feeling the respondents after marriage



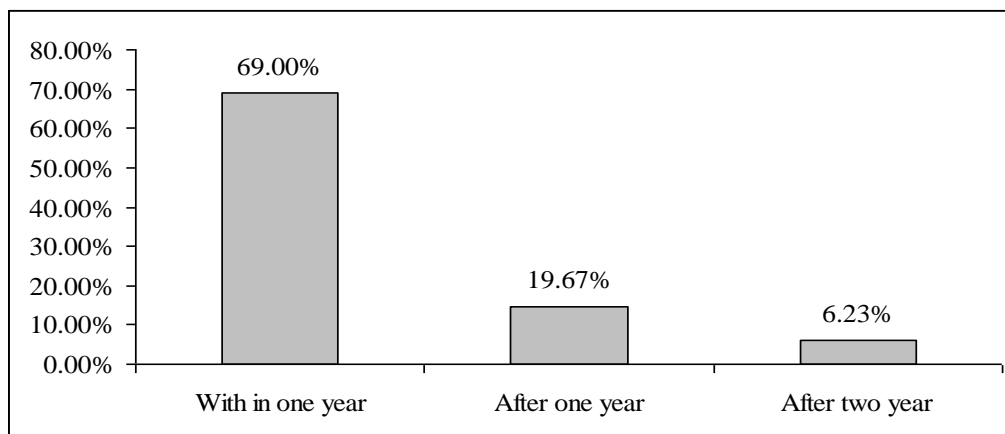
In this figure shows that majority of the respondents 62 percent of women felt moderate the second majority of the respondent weren't satisfied and 19.67 percent were not satisfied after marriage. Likewise the second majority of Dalit respondents 18.33 percent are happy.

Time of First Pregnancy

Time of first Pregnancy is most important factor of teenage marriage. Women's age should be at least 18 years of bearing first child as their physical and mental health is not prepared. The following figure show the time of first pregnancy of the respondents.

Figure No. 3

Time of pregnancy



In this figure shows that the time of first pregnancy of respondents majority of the respondents included in the study were pregnant within one year of marriage which is 69 percent in Dalit community. The second majority of the respondents were pregnant after one year which is 14.71 percent. The study found that only few of the respondents were pregnant after two years from their marriage which is 6.23 percent in Dalit community.

Time of first pregnancy is most important factor of teenage women's are should be at least 18 years for bearing first child the study area most of respondents were pregnant within one year after marriage. All respondent have got pregnant in under the age of 18. So it is harmful for other and child health.

Delivery Place

Usually in rural community the delivery of child is protected at home and some delivery practices in health post or by experienced women its effect on their reproductive health. Delivery practices leads to the death of mother and is equally harmful to child in the study area place of delivery affects maternal and child health. Unhygienic delivery practices led to the women so many problems e.g. bleeding, tetanus, uterine rupture etc.

Safe delivery practice is essential to protect the life and health of mother and her child by insuring the delivery of a baby safety. An important component of efforts its reduce the health risk to mother and children is to increase the proportion of babies delivered under the supervision of health professionals. The national safe motherhood programme encourage women to deliver health facilities are upgraded and provided are delivered at home either with assistance of TBA or relatives and friends. At the national level only 19 percent by births delivered in health post (NDHS, 2002).

Table No. 8

Delivery place

Place of delivery	No. of respondents	Percent
At home	74	82.22
At birthing center	16	17.77
Total	90	100

In this table shows that most of respondents e.g. 82.22 percent place of delivery was at home. It is found that only 17.77 percent of respondents delivery place was at birthing center.

Safe delivery practice is essential to protect the life and health of mother and her child by insuring the delivery of a baby safety. In the national level 39 percent of babies delivery by doctor (NDHS, 2009). But in this study area most of respondents 17.77 percent of babies delivery by doctor. That due to the traditional practice, lack of education and health facilities are the responsible factors which promote delivery at home. It was poor condition in this study are than national level.

Problems of Pregnancy and Delivery Time

Complications are important causes of maternal and child mortality and mortality. Maternal death is defined as any death that occurred during pregnancy child birth an within six week after the birth. In this regard respondents were asked, 'what kind of problems you faced during pregnancy and delivery period?' response of them is given in table 9.

Table No. 9

Problems of pregnancy and delivery time

Problem	No. of respondents	Percent
Heavy bleeding	45	50.00
Back pain	25	27.77
Anaemia	20	22.22
Total	90	100

Table 8 shows 50 percent of the respondents have suffered from heavy bleeding 27.77 percent respondents suffered from back pain and 22.22 percent suffered from anaemia.

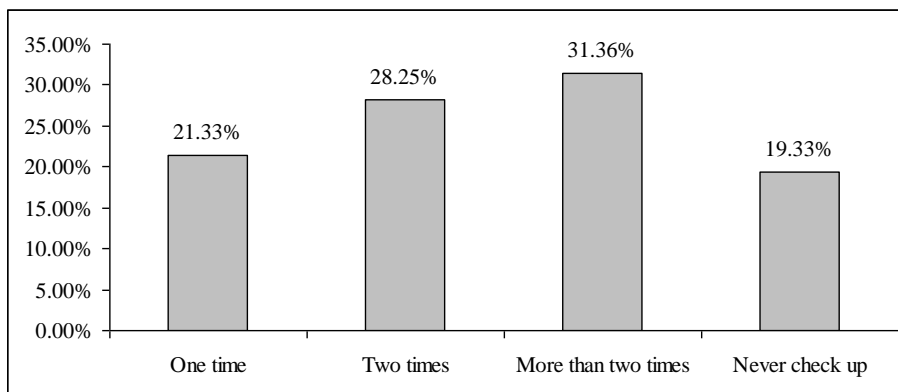
Early pregnancy majority of the respondents have suffered from different type of complication during pregnancy and delivery. The data indicate that larger proportion of married women have suffered from heavy bleeding. So, due to early pregnant lack awareness, poor health condition n low level of educational attainment compare to appropriate g married women.

Health Check up During Pregnancy

Pregnancy is the period from conception to delivery of time of the foetus. Health check up during pregnancy means to examine pregnant mother health during pregnancy period. The national safe motherhood programmed guideline in Nepal recommended at least four times visit should be made soon the mother realize that she is pregnant. The second visit should be made between the fifth and seventh month of pregnancy. The third visit should be made at the beginning of the nine month and last visit should be made the same week that the baby is due But lack of a wareness, poor economic condition, lack of health facilities most of the pregnant women do not go for check up of their health regularly. The status of health check up of the respondents at the time of their pregnancy is presented below.

Figure No. 4

Health check-up during pregnancy of respondents



In this figure shows that the respondent's average has gone for health check up during pregnancy. It is evident from the data that 21.33 percent respondents have gone one time for health check up during pregnancy 28.25 percent responded have gone two times, 31.36 percent responded have visited more than two times health check up during pregnancy and 19.33 percent respondents never visited anywhere for health check up during pregnancy.

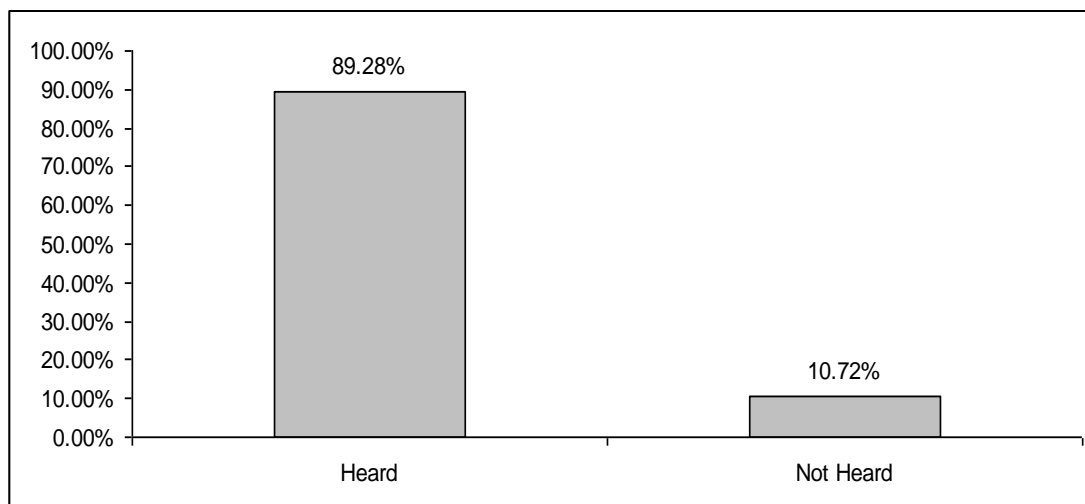
Up during pregnancy the study concludes that due to teenage marriage must of the respondents are known about the importance of health check up during pregnancy Dalit respondents believed in their superstition. Another factor is the poor economic condition which deprives them to access the facilities provided by health post of hospitals.

Knowledge about Family Planning

Family planning is an important aspect of reproductive health of women. The knowledge of family planning determines the maternal and child health. It effects on to marriage family size of the people. The figure below show knowledge of the respondent bout family planning:

Figure No. 5

Knowledge about family planning



In this figure show that most of the Dalit respondents had heard about family planning. The study reveals that most of respondents had knowledge about the family planning devices but they were not enough knowledge about temporary method of family planning and few respondents have not heard yet.

Conclusion

The study has done under the topic 'Causes and Consequences of Teenage Marriage among Dalit Teenagers in Barbardiya Municipality.' The following conclusion is drawn on the basis of analysis of data.

The study has found that the main reason teenager marriage and out traditional culture. These reasons play vital role to increase the rate of teenage marriage. Teenage marriage and pregnancy brings different kinds of health problems in mother as well s children. Similarly the most of the women were pregnant before 19. So, the pregnancy without proper physical development is very kits for mother and child. Mother are died due to early postnatal. In the case of antenatal and postnatal check up it is also poor which creates many problems among early pregnant. Anaemia, weakness, swelling bleeding one the common health problem of early pregnant women. Majority of the respondents have got married by decision of their parents. They do not have more knowledge about the different consequences the teenage marriage. They do not know about the right age of marriage so it is increased the rate of early marriage.

The women married at appropriate age are conscious about demographic variable a com pored to teenage married women. Teenage married women are facing different kind of physical and mental health problems. Most of the women married at appropriate age attempted their delivery at health post and hospital. The analysis of result clearly shows that most of the teenage married women do not care for regular and complete health check up during pregnancy due to lack up knowledge and poor economic condition.

Overall observation and interview indicate that most of the respondents are suffering from different health problems due to the teenage marriage. Among of the respondents they have expressed their views that women are backward in society due to male dominant culture and lack of education.

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Effectiveness of Collaborative Writing Strategy in Improving EFL Students' Writing Skill

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Abstract

The ability to write efficiently and effectively in English is significant for academic success. The academic achievement of students who are proficient in writing skills tends to be better than that of students who are less proficient. So, the teachers have to choose effective teaching writing strategies which can assist in enhancing students' writing skill. In this perspective, the present quantitative study conducted employing quasi-experimental methodologies attempts to explore the effectiveness of Collaborative Writing (CW) in improving the writing skill of grade or class ten English as Foreign Language (EFL) students. The sample population consisted of 60 students studying in grade 10 at one secondary-level institutional school located in Banke district. I employed convenience sampling to select the school and typical case sampling, a kind of purposive sampling to select the sample population. Selected students were divided into Control Group (CG) and Experimental Group (EG) based on the sections to which they studied or related. CG was taught using the conventional strategy whereas EG was taught by using the CW strategy. I employed test (pre and post-test) technique to collect the data and the collected data were analysed employing the descriptive analysis technique of quantitative data analysis. The result of the study indicated that CW is more effective for developing the writing skill of secondary-level EFL students. Therefore, teachers are suggested to employ CW technique to enhance the writing skill of the students in English.

Key Words: conventional strategy, collaborative writing, strategy, writing skill

Introduction

A teacher can use several strategies to enhance the writing skill of the students. CW is one of the popular strategies used in teaching writing. According to Barkley et al. (2005), CW is a strategy that requires students to work in pairs or triads to write a formal paper together. It offers a real learning environment where students do not only develop their writing skills but also their critical thinking and decision-making skills. It encourages students to participate more actively in writing assignments. Additionally, CW helps students to improve their writing skill by encouraging their participation, self-assurance, and responsibility in writing activities. Students of various abilities can collaborate to complete a writing task in CW (Storch, 2005). He further adds that students may work together in all stages of the writing process in CW. Although students write together, McDonough et al. (2015) contend that each student is nonetheless accountable for producing better individual writing. Additionally, students have the chance to produce ideas and provide feedback to one another through CW (Dobao & Blum, 2013). CW helps students enhance their writing in terms of content, structure, and accuracy (Shehadeh, 2011). According to Watanabe et al. (2007), CW strategy can enhance students' motivation in writing, increase vocabulary and change the writing habits of the students.

Despite its benefits, CW is not very common in Nepalese classrooms, particularly at the institution where this study was conducted. The teachers emphasize products rather than providing them opportunities to work in groups. They ask students to complete the written assignments individually rather than involving them to complete the work collaboratively. More focus is given to the mechanical aspects of writing such as mechanics,

spelling, grammar, writing process, teamwork and social skills in writing. If the students are not involved in collaborative writing, critical thinking and values of collaborative work cannot be nurtured among the students. Thus, this current study is aimed to investigate the effectiveness of CW strategy in improving secondary level EFL students' writing skill.

Review of Related Literature

Strategies of Teaching Writing

According to Ur (2003), the aim of teaching writing is to equip students with the skills necessary to correctly create a variety of written documents in their native tongue. Additionally, writing is one of the most crucial skills to develop in second or foreign language. Therefore, teachers must consider the most effective teaching strategy, writing resources, and supplementary materials used in teaching in writing. The teacher should be able to identify commonly used strategies of teaching writing and to select the strategy which is the best suited according to the interests, expectations and level of the students. Khatib and Meihami (2015) also state that teachers must be able to choose to use a specific technique to teach writing according to the classroom context. Moreover, a teacher should select a technique of teaching writing which allows opportunities to work in groups to complete the writing task. Thus, the teacher's task is to select a technique that helps teachers to facilitate their students in developing ideas and organizing them into good writing. The following sections discuss two widely used strategies in teaching writing.

Conventional Strategy

In traditional writing instruction, most of the teachers allocate a certain amount of time and ask students to complete a writing assignment individually without taking the various stages of the writing process (Rollinson, 2005). Teachers rarely encourage students to brainstorm on a given topic (Widodo, 2013). The teacher assigns a topic and asks the students then compose essays in another stereotype without any assistance from the teachers. Students work independently to develop and effectively communicate their thoughts. Additionally, the traditional approach does not encourage students to consider other writing-related factors except organization, content, grammar, mechanics, and vocabulary. Teachers frequently limit their attention to grammar standards when assigning writing assignments to better prepare their students for tests and exams. Students are therefore given the task of learning grammatical rules, vocabulary and translation skill to make them proficient in writing. It does not encourage in-class debate or discussion on the given topic to write. In conclusion, this method of writing instruction frequently produces passive learners who lack imagination and involvement.

Collaborative Writing Strategy

In CW, two or more individuals work together to write, revise, polish and prepare the entire text or a document based on their ideas. Barkley et al. (2005) claim that in CW, the class is divided into groups and members actively participate to write the assigned tasks. Furthermore, each of the members of the groups actively involves themselves in brainstorming ideas, gathering and organizing information to create an outline, drafting the writing, revising, and editing the writing. Thus, in contrast to traditional teacher-dominant classrooms, CW emphasizes participatory teaching and learning (Ong & Maaof, 2013).

Murray (1992) claimed that CW is essentially a social activity in which students seek specific information and points of view to be shared to compose writing. Each member of the team takes ownership of their part in the writing process. Sharing knowledge, making decisions, and resolving issues are all part of CW. According to Dale (1997), it fosters cooperative learning with the goal of producing a quality piece of writing. The teacher conducts CW in the following steps:

- Divide the class into groups of at least three students each;
- Choose a topic for each group;

- Begin by outlining each group's plan to conduct research and gather information for their paper;
- Require the students to consider the purpose of their writing and the structure of the content.
- A first draught of each student's paper is produced because of their collaborative efforts and use of their own ideas.
- After that, the student reads their work to see if it is appropriate or not and makes any necessary adjustments to the organization, skill, grammatical, and lexical accuracy.
- The best version of the revised text is then copied out by the students and sent to the teacher; the final step is teacher evaluation, during which the teacher provides feedback, makes a comment, and edits the students' writing.

There are many benefits to using a CW. Collaborative learning naturally provides feedback and promotes a helpful setting within which to manage conflict resolution. When a student engages in writing individually, he/she may face difficulties in generating idea. But, in CW students continuously interact with peers which gradually leads to feedback. Zhao (2010) asserts that the usage of feedback in writing in a second language is essential for enhancing students' writing abilities. According to Bijami et al. (2013), giving students feedback on their work helps them become proficient writers. They further add that feedback helps students to develop their critical thinking skill which is seen as important in solutions required to solve the difficulties of writing.

CW also gives its participants the chance to socialize. Socialization take place When ideas and opinions are exchanged, and interaction takes place in the classroom. This strategy has the potential to improve peer understanding in each task since through the writing process students continuously participate in dialogue and take and give support from peers which is more helpful than instruction given by the teachers. In line with this, Dale (1997) stated that when co-authoring, students can express writing-related thoughts and communicate with one another to improve their interpersonal skills.

Students engage in a variety of tasks while writing collaboratively, including problem-solving, knowledge sharing, and exchanging opinions. Students, thus, take responsibility for their own learning throughout the writing process. Their confidence grows as a result of this. Self-assurance will eventually increase students' motivation in writing. Motivation is seen as a key element of successful collaborative learning (Farrah ,2011). Additionally, Ong and Maarof (2013) said that when students work collaboratively, they become happier with their work and performance. Collaborative learning reduces anxiety and boosts self-confidence. Moreover, collaborative works provide students more opportunities to speak the target language in low anxiety circumstances. According to Storch (2001), CW decreases anxiety and an increase in motivation in the students.

Collaboration in writing enables students to think more critically. Through the process of solving problems, critical thinking develops. It grows through conversation, peer assessment, and discussion. Mandusic and Blaskovi (2015), argued that integrating cooperation into the classroom help students to develop their creative thinking.

CW has a significant effect in improving students writing skill. Several studies have proved the effectiveness of CW in enhancing students' writing abilities. According to Gousseva (2000), students who are taught to write in groups outperform those who are taught to write alone. According to Storch (2005), CW gives students the chance to share ideas and critiques with one another while also enhancing the quality of their writing. CW fosters respect and teamwork among students despite their varied backgrounds. The students' perceptions of the use of CW are related to other findings. According to a long-term study by Shehadeh (2011), many students have good attitudes toward CW and find the activity enjoyable. Dobao and Blum (2013) also assert that CW gives students additional opportunities to expand their horizons in terms of exchanging knowledge and ideas. According to Khodabakhshzadeh and Samadi (2017), students have positive attitudes toward CW because it helped them become more motivated, use peer feedback while studying, gain a comprehensive understanding of the subject,

change unproductive writing habits, and increase their vocabulary knowledge. CW allows learners to be more critical in their thinking process. Hussain (2004) advocated that the incorporation of collaboration in learning makes students enhance their creative thinking. Mandusic and Blaskovi (2015) also claimed that critical thinking is nurtured through discussion and peer opinion and evaluation.

Therefore, using a collaborative approach helps students produce writing that is of a higher calibre. The process of a pair of students or a group of students creating a piece of writing where cooperation and contribution of the group members plays a vital part is the core of CW. As a result, the writing's final product will be superior to what it was before, and social contact between professors and students will also result. Teachers, acting as a facilitator in the CW process, must demonstrate how a group or pair of students critique each other's work, seek assistance from others, and discuss and negotiate writing-related issues. Murray (2006), Storch (2009), and Mulligan and Garofalo (2011) offer CW guidelines in response to the need for structural guidelines. These guidelines enable students to complete multiple tasks within a single piece of writing while also simultaneously reviewing and editing the work of others. However, while teaching writing in a Nepalese environment, teachers still frequently employ traditional methods of instruction.

Methodology

I adopted quantitative approach and quasi-experimental methodology to examine the effectiveness of CW in enhancing the writing skill of the secondary-level EFL students. The sample population of the study consisted of 60 students who studied in class ten at one of the institutional schools of Banke district in the academic year 2079/80. I employed convenience sampling to select the school and typical case sampling, a type of purposive sampling to select the sample population of the study. Class ten was targeted in the study since I was working as an academic advisor in the same school for last five years and I used to teach them on days when the English teacher was absent. So, I was very much familiar to them. There were two sections in class ten, and they were named section 'A' and 'B'. I assigned section 'A' as CG and section 'B' as EG. The number of students in CG and EG were equal i.e., 30 because the school had policy of not admitting not more than 30 students in each section to maintain the quality of education. So, the total number of sample population became 60. I took two sessions to both groups for clarifying the research process prior to pre-test. After that I took written consent of the students. Then, I administered pre-test to both groups on May 19, 2022. From the day after that intervention started. I taught CG employing conventional technique of teaching writing and EG employing CW technique. Teaching continued for thirty consecutive days (from May 20, 2022, to June 26, 2022) except on public holidays. Thus, the CG was taught for 30 days and the EG also for 30 days. On the 31st day i.e., on June 27, 2022, I administered post-test.

The pre and post tests were prepared based on the textbook prescribed for class 10 by the Curriculum Development Center under the Ministry of Education. The same pre and post tests were administered to both groups. Both tests consisted of ten questions and each question carried 10 full marks. Thus, full mark of pre and post-test was fifty. The time duration of pre and post-test was one hour and 30 minutes. Pre and post tests were presented to a jury of TEFL professionals to ensure face validity of pre and post-test. The time given for responding to the test and reliability has been determined through a pilot administration of both tests. They were administered to the students of class ten students studying another institutional school of Banke district i.e., different from the selected school for study. To get the internal consistency among the components of the test, Alpha Cronbach Formula has also been used. The reliability coefficient was found to be 0.82. The subjects' performance was evaluated by two scorers for both pre and post-tests. To ensure the reliability of the rating process, inter-scorer reliability was calculated. It was 0.81 which appeared as an acceptable value of interrater reliability.

The researcher has employed an analytical scoring rubric proposed by O'Malley and Pierce (1996) for the written answers of the students. This grading rubric is made up of five rated components and a succession of numerically

scored ratings. It has allotted four points to each component. As a result, the student's greatest possible grade is 40, while the lowest possible grade is 10.

The data received from the two groups' pre and post-tests were analysed employing the descriptive analysis technique of quantitative data analysis. The t - test formula was also used to determine whether there is a statistically significant difference in pre-test results between the experimental and control groups.

Results

Holistic Comparison Between Pre-test and Post-test Scores in Percentage

The analysis of scores obtained by EG and CG in the pre-test and post-test are presented holistically and item-wise. Holistic comparison of the pre-test and post-test result is as follows:

Table No. 1

Holistic comparison between pre-test and post-test scores in percentage

Group	Average score in pre-test	Average score in post-test	D	D%
EG	25.13	29.23	4.1	16.31
CG	24.73	25.76	1.03	4.16

The result presented in the above table shows a holistic comparison of average marks which shows that the CG has the average score of 24.73 and 25.76 in pre-test and post-test respectively. In the post-test CG increased its average score by 1.03 or 4.16%. In the same way, the EG has its average score of 25.13 and later in the post test it has increased its average score by 4.1 marks or 16.31%. In other word, EG has increased its average score from 25.13 to 29.23. The result shows that EG has got better improvement than CG after the treatment of CW in teaching writing.

Holistic Comparison of the Pre-test Scores

For the process of data collection, different test items were administered, and average scores obtained by the students in each item in the pre-test were tabulated and calculated for the analysis. The mean score of both groups in every test item was used in the 't'-test. The calculated value and tabulated value of 't' were compared to see whether there was a significant difference or not in both groups.

Table No. 2

Holistic comparison of the pre-test scores

Group	N	Mean	SD	Var.	Two tailed tests	Level of Significance	Remarks
EG	30	25.13	7.50	56.34	0.24	Two tailed tests at 0.05	0.24<1.96
CG	30	24.73	5.05	25.52			

In the experimental and CGs, the numbers of students were 30 in each. The calculated value of 't' was too lower than the tabulated value. So, we can say the two population groups were not significantly different. The standard deviations of EG and CG were 7.50 and 5.05 respectively. The mean of the two populations was not significantly different (i.e., 25.13 and 24.73). The two-tailed test was used to find the value of 't' although the mean was similar between the groups, the variance was high (i.e., 56.34>25.52) in the EG. The calculated 't' value (0.24) is too low to the rejected null hypothesis. It was also found that there was no difference between the mean two groups at 0.05 level. So, the experimental and CGs were concluded to have balanced in abilities in writing.

Holistic Comparison of Post-test Scores

The post-test was administered to find out the effectiveness of CW in teaching writing skill. No information was given to the students so that they would be administered the post-test using the same pattern of test items. Finally, the post-test was administered, and answer sheets were collected and checked by the researcher himself.

Table No. 3

Holistic comparison of post-test scores

Group	N.	Mean	SD	Var.	Two tailed test	Level of Significance	Remarks
EG	30	29.23	6.21	38.64	2.19	Two tailed test at 0.05	2.19>1.96
CG	30	25.76	6.09	37.12			

The calculated value of 't' (i.e., 2.19) is greater than tabulated value (i.e., 1.96). That's why, two mean achievements of both groups were compared statistically using 'two tailed test' and it was found that there was a significant difference between two means. The evidence of the result of significant difference between the two means was certainly due to the treatment 'X' provided to the EG because both the groups were statistically homogeneous before the treatment 'X'. Here the null hypothesis $H_0: \mu_1 = \mu_2$ is rejected and the alternative hypothesis $H_a: \mu_1 \neq \mu_2$ was accepted. That is why the study concluded that CW is effective for developing writing.

Comparison of Pretest Scores of Both Groups in Formal Writing

For the process of data collection, formal writing test items were administered, and average scores obtained by the students in each item in pre-test were tabulated and calculated for the analysis. The mean score of both groups in every test item were used in 't' test. The calculated value and tabulated value of 't' were compared to see whether there was significant difference or not in both groups.

Table No. 4

Comparison of pretest scores of both groups in formal writing

Group	N	Mean	SD	Var.	Two tailed tests	Level of significance	Remarks
EG	30	7.33	1.73	3.01	0.38	Two tailed test at 0.05	0.38 < 1.96
CG	30	7.73	1.09	1.72			

The result shows that the mean score of EG is 7.33 and the mean score of CG is 7.73. The standard deviation of both groups is 1.73 and 1.09 respectively. The variance of two groups is 3.01 and 1.72 respectively. The calculated 't' value with respect to mean difference is 0.38 which is too lower than tabulated value (i.e., 1.96). The result shows that there is no significant difference between the achievements of both groups.

Comparison of the Pre-test Scores of Informal Writing

In this item, five item questions were prepared to complete which together carried out 38 marks in informal writing. The summary of the statistical calculation of both groups (EG and CG) presented in the following table.

Table No. 5

Comparison of the pre-test scores of informal writing

Group	N	Mean	SD	Var.	Two tailed test	Level of significance	Remarks
EG	30	17.8	6.25	39.09	0.57	Two tailed tests at 0.05	0.57<1.96
CG	30	17	4.39	19.33			

The result presented in the above table shows that the average score of EG s is 17.8 and average score of CG is 17. The standard deviation of both groups is 6.25 and 4.39 respectively. Similarly, the variance of EG is 39.09 and 19.33 is of CG, when 't' test was calculated as 0.57, it was clear that there was no significant difference between the achievements of both groups as 't' value was too lower than tabulated value (i.e., 1.96).

Comparison of the Post-test Scores of Formal Writing

For the process of data collection, formal writing test items were administered, and average scores obtained by the students in each item in post-test were tabulated and calculated for the analysis. The mean score of both groups in every test item were used in 't' test. The calculated value and tabulated value of 't' were compared to see whether there was significant difference or not in both groups.

Table No. 6

Comparison of the Post-test Scores of Formal Writing

Group	N	Mean	SD	Var.	Two tailed test	Level of significance	Remarks
EG	30	8.76	1.01	1.038	2.19	Two tailed test at 0.05	2.19>1.96
CG	30	8.06	1.43	2.06			

As shown in the table, the mean score of EG was 8.76 and the mean score of CG was 8.06. The standard deviation of both groups was 1.01 and 1.43 respectively. The variance between the two groups was 1.038 and 2.06 respectively. The calculated 't' value with respect to mean difference was of 2.19 which is greater than tabulated value which shows that there is a significant difference in post-test.

Comparison of the Post-test Scores of Informal Writing

The questions were prepared from the textbook of grade ten for this item and full marks allocated for this test was 38. The summary of statistical calculation of both groups in informal writing item is given below:

Table No. 7

Comparison of the post-test scores of informal writing

Group	N	Mean	SD	Var.	Two tailed test	Level of significance	Remarks
EG	30	20.46	5.26	27.68	1.97	Two tailed test at 0.05	1.97>1.96
CG	30	17.7	5.57	31.13			

The information tabulated in the above table shows that the average score of EG s is 20.46 and average score of CG is 17.7. The standard deviation of both groups is 5.26 and 5.57 respectively. Similarly, the variance of EG is 27.68 and 31.13 When 't' test was calculated as 1.97, it was clear that there was significant difference between the achievements of both groups as 't' value was higher than tabulated value (i.e., 1.96).

Discussion

The main aim of this research was to find out the effectiveness of CW in enhancing writing skill of secondary level EFL students. The study has justified the effectiveness of CW in improving writing skill of the students based on the scores average obtained by control and EG. The study's findings support the claim that students who are taught using a CW technique get higher writing skill scores than students who are taught using a conventional strategy. The average score of CG in pre-test in formal and informal writing was 7.73 and it was 17 in writing. Similarly, the result of EG in writing was 17.8 and it was 7.33 in formal writing. But the result became different in post-test the average mean of CG in post-test was 8.06 in formal writing. Likewise, the result of EG in post-test in formal writing was 8.76 and in informal writing 20.46.

There was 0.4 average score difference between experimental and CGs pre-test but there was 3.47 average score between them. In Formal writing comparison between experimental and CG in pre-test obtained 0.4 average score higher than EG whereas in post-test EG got average 0.7 score higher than CG. In informal writing comparison between experimental and CG in pre-test 0.8 averages score different whereas in post-test EG got 2.76 average marks higher than CG.

The results are consistent with a study by Kozar (2006), who found that collaborative learning approaches have an impact on students' learning and likely to improve performance. The idea that students' knowledge is impacted by collaborative learning was also raised. According to the findings, 67% of respondents prefer writing in groups than writing alone. This is consistent with the findings of Jalilie and Shahrokhi's study, which found that students' attitudes toward teamwork were good.

Additionally, the survey shows that 46.9% of participants strongly agreed that problem solving is made easier by collaborative learning. This concurs with Farrah's (2011) research. His research revealed that collaborative learning can improve problem-solving techniques. Collaborative learning has a considerable impact on students' critical thinking. According to Talib and Cheung's (2017) research, CW helps students become better writers. According to a study done by Grief in 2007, CW is a supportive strategy. Highlighting one's assets and weaknesses is beneficial. Therefore, this strategy can change the focus from individual weakness to a group's overall strength. In his learning theory, Vygotsky (1978) also made the argument that students who engage in a cooperative setting have higher levels of thinking than those who operate independently. Additionally, in the current study, the method collaboration gave students a place to get helpful comments.

Conclusion and Implication

The study found that students in the EG made more progress in improving their writing skills than students in the control group. Therefore, CW is more effective than the conventional method of teaching writing. Furthermore, collaborative language learning allows students to build critical and creative thinking skills and maximise their inner potential. With their direct involvement, learners gain teamwork skills by working jointly and sharing ideas. Moreover, CW is a viable and successful strategy for teaching writing. CW can be utilized as an educational tool in the classroom to encourage student collaboration and create a healthy social atmosphere. CW has the potential to be an alternate strategy for individual writing to tackle deficiencies and limitations of the writing process individually. The findings demonstrated that CW is more practical than working alone, particularly when teaching writing skills. As a result, teachers can use the findings of this study to help their students improve their writing skills. Students not only submit their ideas, but they also participate in discussions and learn from their group members. Furthermore, students can receive criticism as well as guide others. As a result, students can practice, and sight writes from a broader perspective as both a writer and a reader. Incorporating CW as a component of training can be extremely beneficial to students who are eager to polish their writing skill.

Future research can examine the influence of CW on text structure as well as the effects of this strategy in composing various types of writing such as reports and projects. Future research should investigate how the collaborative strategy affects other language abilities including reading, listening, and speaking.

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Eight Moments in the History of Qualitative Research

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Abstract

This article provides an overview of the history of qualitative research, from its origins in colonial ethnographies to the development of formalized methods, and the pluralism and interpretive approaches of the blurred genres period. The article also discusses the challenges and controversies faced by qualitative research in the present and future, leading to the rise of new approaches such as mixed-method research and critical conversations about diversity, moral discourse, and global society. The article also describes the three perspectives used to classify research: application, objective, and mode of inquiry. Qualitative research is a method of scientific inquiry that uses data collection and analysis, primarily focused on understanding an issue or solving a problem. The article explores the eight moments of qualitative research development as identified in 'The Sage Handbook of Qualitative Research', from the traditional phase to the fractured future. Each moment is characterized by a different paradigm, ontology, and methodology, and has been influenced by key contributors such as Bronislaw Malinowski and Margaret Mead.

Finally, the article highlights the growing importance of qualitative research in the field of social science research, which is now considered equal to quantitative research. The mixed method approach, which links both quantitative and qualitative research, has also gained popularity. The article concludes by emphasizing the value of scientific inquiry and the importance of understanding the world around us in all its complexity and diversity.

Keywords: eight moments, qualitative research, paradigm, ontology, contributor

Introduction

The history of qualitative research has been a long and complex one, with numerous pivotal moments and contributions from a diverse array of scholars and disciplines. From its origins in the colonial ethnographies of the 17th to 19th centuries, to the development of formalized methods during the modernist phase, and the pluralism and interpretive approaches of the blurred genres period, the evolution of qualitative research has been marked by constant change and innovation. In recent times, the methodological controversies and challenges of the present and future have given rise to new approaches such as mixed-method research and critical conversations about diversity, moral discourse, and global society. Overall, the history of qualitative research is a testament to the value of scientific inquiry and the importance of understanding the world around us in all its complexity and diversity.

Research

The history of qualitative research is a testament to the value of scientific inquiry and the importance of understanding the world around us in all its complexity and diversity. Research is a systematic process of inquiry that involves the collection, analysis, and interpretation of data to gain new knowledge or expand existing knowledge. Research is creation of new knowledge and expansion of existing knowledge. Some scholar has defined research as following. Kothari (2004) defines research as “the method, which man employs for obtaining the knowledge of whatever the unknown, can be termed as research”(p. 1). Another scholar John W. Creswell defines research as systematic task that answer the curiosity. According to Creswell (2012), research means a process of “steps used to collect and analyze information to increase our understanding of a topic or issue. It

consists of three steps: pose a question, collect data to answer the question, and present an answer to the question” (p. 26). Similarly, Cook defines research as “an honest, exhaustive, intelligent searching for facts and their meanings or implications regarding a given problem” (cited in Pandey, 2015, p. 8). From the above definitions, we can conclude that research is a method of scientific inquiry which uses data collection and analysis. It is basically for understanding an issue or solving a problem.

Types of research

Research can be classified on the basis of perspective. According to Kumar (2014), there are three types of research based on perspective. The first perspective is the application perspective, which includes two broad categories: pure research and applied research. Pure research, as defined by Bailey (1978), involves developing and testing theories and hypotheses that are intellectually challenging to the researcher but may not have practical applications in the present or future. Applied research, on the other hand, aims to find solutions for immediate problems faced by society or industrial/business organizations (Kothari, 1990). Objective perspective: If you examine a research perspective of its objectivities, broadly a research endeavor can be classified as descriptive, correlation, explanatory or exploratory. Descriptive research describes systematically about phenomenon, problem or issue. Correlation research discovers or establishes the relationship between dependent and independent variables. Explanatory research attempts to clarify why and how there is relationship between two aspects of a situation or phenomenon. Explanatory research is that research where research is carried out from a view point of the objectives of a study. Exploratory research is carried out when a study is undertaken with the objective either of exploring an area where little is known or of investigating the possibilities of undertaking a particular research study.

Mode of enquiry perspective: From the prospective of mode of enquiry, research can be classified into three approaches. They are the quantitative approach, qualitative approach and mixed approach.

Based on the nature of information, there are two types of research approaches: Quantitative and Qualitative (Kothari, 2004; Pandey & Pandey, 2015). However, Creswell suggests the third research design called ‘mixed method research’. The quantitative research method is mostly used in hard-sciences research studies whereas psychology and social sciences mostly use qualitative research methods. Because of criticism on the qualitative research method as unable to theorize the findings, nowadays, the mixed method design is getting popularity in social sciences (Creswell, 2014a). As this paper only focuses on the history of the qualitative research method, we are not going to discuss more on the quantitative method and mixed methods.

Qualitative research

Qualitative research is concerned with phenomena relating to or involving quality or kind (Kothari, 2004). When information is in the form of textual form, we use qualitative research (Pandey & Pandey, 2015). In qualitative research “data typically collected in the participant’s setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data” (Creswell, 2014a, p. 32). In social science research studies, quantitative analysis cannot function well as the data are not numerical. Therefore, to deal with qualitative data, we use qualitative research (Denzin & Lincoln, 2018).

History of Qualitative Research: The Eight Moments

The development of qualitative research has not been very long. Although the works of the Greek skeptical philosophers Sextus Empiricus, who conducted a cross-cultural survey of morality in 2nd century B.C. and Herodotus, who wrote cross-cultural as well as historical issues, these were not recognized as qualitative inquiry until the 20th century (Denzin & Lincoln, 2018). However, during the 17th century the western researcher, who observed the customs, practices, and behaviours of “primitive” societies, sought to locate such diversity into new theories of racial and cultural-historical origins. During the 17th to the 19th century ‘colonial ethnographies’ were done and written by western explorers, missionaries, and colonial administrators (Denzin & Lincoln, 2018).

During the 1920s and 1930s, the work for the Chicago School in the USA highlighted the central role of qualitative research in social research. However, other disciplines like history, medicine, nursing, social work, and communication contributed to the development of qualitative research approaches (Given, 2008).

Qualitative research was equally popular in the American as well as the European continents. In Europe, there is a different history of it as mentioned above. In this paper, we will see the American history of qualitative research. 'The Sage Handbook of Qualitative Research' has mentioned eight moments of the development of qualitative research (Denzin & Lincoln, 2018).

First moment: The traditional phase (1900-1949)

The traditional phase of qualitative research, spanning from 1900 to 1949, was marked by a focus on discovering valid and objective details about the cultures and traditions of "others" through the work of western scholars. During this time, researchers were often referred to as "lone ethnographers" who were committed to imperialism and the monumentalization of their subjects. The main paradigm of this period was the positivist scientific paradigm, which relied on the belief in a single reality that could be objectively observed and measured. In terms of ontology, the focus was on an objectivist ontology that emphasized the existence of a single reality. Methodologically, researchers relied on accounts of field experiences and lone-ethnography, including classic ethnographies, to try to reflect on the experiences of the subjects being studied. Bronislaw Malinowski and Margaret Mead were two of the key contributors to the traditional phase of qualitative research, whose work laid the foundation for future developments in the field. The main characteristics of this period were:

- Paradigm: Positivist scientific paradigm
- Ontology: Objectivist ontology (single reality)
- Methodology: Accounts of field experiences, lone-ethnography including classic ethnographies, try to reflect on the experiences
- Main contributors: Bronislaw Malinowski and Margaret Mead

Second moment: The modernist phase (1950-1969)

This period is marked by attempts to formalize qualitative research by making qualitative methods as rigorous as quantitative approaches. For this purpose, many textbooks were published in the USA (Given, 2008; Hubbard, 2016). During this period, there was a shift from the lone-ethnographer model to the use of research teams, which allowed for more diverse perspectives and greater rigor in research design (Hubbard, 2016). This period also saw the emergence of new qualitative research methods such as participant observation and content analysis. The focus was on understanding the experiences and perspectives of marginalized groups such as women, ethnic minorities, and LGBTQ+ communities. This phase also brought a renewed interest in the role of the researcher, with scholars such as Howard Becker and Erving Goffman emphasizing the importance of reflexivity and the researcher's role in shaping the research process (Given, 2008). The main characteristics of this period were:

- Paradigm: Critical paradigm (giving the marginalized a voice and presence)
- Ontology: Subjectivist ontology (multiple reality)
- Methodology: Observation of deviance and social control in specific settings, such as classrooms, and society; evolve of interpretive theories (such as ethnomethodology and feminism) and grounded theory.
- Main contributors: Harold S. Becker, Blanche Greer, Everett C. Hughes, Barney G. Glaser, and Anselm L. Strauss

Third moment: Blurred genres (1970-1986)

During the third moment of qualitative research, characterized by pluralism, open-mindedness, and interpretive approaches, various theoretical models and understandings of the objects and methods stood side by side, from semiotics to neo-Marxist theory and from critical theory to post-positivism. This allowed researchers to choose and weigh them against each other or combine them. The boundaries between the social sciences and humanities became blurred as social scientists used theories, methods, and concepts of humanities (Given, 2008; Hubbard, 2016). Constructivist ontology was adopted, which acknowledges the existence of multiple realities. Researchers were provided with diverse strategies and techniques, including narrative, phenomenology, feminism, and hermeneutic approaches, symbolic interactionism, ethnomethodology, semiotics, case studies, and biographical research. Researchers acted as bricoleurs, utilizing multiple sources of data, methods, and approaches to answer their research questions. Additionally, the introduction of computers assisted in data analysis (Given, 2008). The main contributors of this phase were Clifford Geertz, George E. Marcus, Michael F. Fischer, Victor Turner, Edward Bruner, among others (Creswell, 2014). The main characteristics of this period were:

- Paradigm: Naturalistic, postpositivist and constructivist paradigms
- Ontology: Constructivist ontology (multiple reality)
- Methodology: Providing researchers with diverse strategies and techniques, including narrative, phenomenology, feminism and hermeneutic approaches, symbolic interactionism, ethnomethodology, semiotics, case studies, biographical research; researcher as a bricoleur; introduction of computers in assisting data analysis
- Main contributors: Clifford Geertz, George E. Marcus, Michael F. Fischer, Victor Turner, Edward Bruner, etc.

Fourth moment: Crises of representation (1986-1990)

The Crisis of Representation period led to a renewed focus on the politics of representation and power dynamics in qualitative research. Researchers were urged to engage with issues of subjectivity, reflexivity, and positionality in order to better understand how their own social location influenced their research process and findings. This period also saw the emergence of new research methods and approaches, such as autoethnography and critical race theory, which aimed to challenge dominant power structures and amplify the voices of marginalized communities. Additionally, there was a growing emphasis on collaborative and participatory research, where researchers worked in partnership with communities to co-create knowledge and promote social change. Overall, this period marked a significant shift in qualitative research towards a more reflexive, critical, and socially-engaged practice. The main characteristics of this period were:

- Paradigm: Feminist, culturalist, racial, and ethnic paradigms
- Ontology: Critical theory (questioning) and subjectivist ontology (multiple reality)
- Methodology: Issues of validity, reliability, and generalizability. The evaluation of research and findings became a central topic in methodological discussions.
- Main contributors: Clifford Geertz, George E. Marcus

Fifth moment: The postmodern period of experimental ethnography (1990-1995)

During the postmodern period of experimental ethnography (1990-1995), qualitative researchers continued to address the crises of representation and sought new approaches to ethnographic writing. The focus shifted from grand theories and narratives to situation-specific and localized theories that better fit qualitative research (Given, 2008). According to Hubbard (2016), this period emphasized the importance of theories and narratives that were

tailored to specific, delimited, local, historical situations and problems. The postmodernist paradigm, including moral and critical perspectives, guided research during this period, and researchers adopted experimental ethnography, action-based and activist research, and local, small-scale theories (Given, 2008). Notable contributors during this period included Franz Boas, Bronislaw Malinowski, Ruth Benedict, and Margaret Mead (Hubbard, 2016). The main characteristics of this period were:

- Paradigm: Postmodernist paradigm including moral and critical perspectives
- Ontology: Localization of grand-theories, theories are read like narratives.
- Methodology: Experimental ethnography, action-based and activist research and local, small-scale theories better fit qualitative research.
- Main contributors: Franz Boas, Bronislaw Malinowski, Ruth Benedict, and Margaret Mead

Sixth moment: Post-experimental inquiry (1995-2000)

The post-experimental inquiry period emphasized the use of creative techniques in qualitative research, such as poetry, drama, and multimedia approaches, to express lived experiences in new ways (Given, 2008). The researchers aimed to democratize qualitative research by engaging with diverse voices and perspectives in their work. As Aronson, Ellsworth, Carlsmith, and Gonzales (1998) noted, this approach allows for the exploration of "multiple realities, multiple perspectives, and multiple voices" (p. 4) in the research process. This period also saw a focus on the connection between qualitative research and democratic policies, with researchers exploring the ways in which their work could inform and shape public discourse and policy-making (Hubbard, 2016). The main characteristics of this period were:

- Paradigm: Postmodernist paradigm
- Ontology: Democratization of qualitative research
- Methodology: Use of poetry, literary forms, autobiography, multimedia techniques in ethnographic writings.
- Main contributors: Aronson, E., Ellsworth, P. C., Carlsmith, J. M., & Gonzales, M. H.

Seventh moment: The methodologically contested present (2000-2004)

The methodologically contested present has been described as a period of conflict between the traditional objectivist approaches to research and the more interpretive, reflexive approach of qualitative research (Given, 2008). Some researchers have criticized qualitative research for not being evidence-based enough, demanding more scientific methods to back up its claims (Braun & Clarke, 2006). However, others have argued that qualitative research offers a valuable contribution to knowledge creation, particularly in understanding complex social phenomena (Denzin & Lincoln, 2000). Despite these challenges, new researchers across various disciplines continue to adopt the reflexive and interpretive approach of qualitative research (Given, 2008).

- Paradigm: Extreme postmodernist paradigm
- Ontology: Reflexive and interpretive ontology with objectivism
- Methodology: Evidence-based approaches to practice and knowledge, using objectivist models and experimental techniques
- Main contributors: Many researchers.

Eighth moment: The fractured future (2005- present)

The fractured future (2005-present) marks a period where qualitative researchers are challenged to address the methodological backlash and engage in critical conversations about the diversity of human life, including

experiences of freedom and control in a global society. Researchers are revisiting the demands of moral discourse and the sacred in their work (CourseHero, 2019). According to Creswell (2013), mixed-method research has emerged as a viable approach to bridging the gap between qualitative and quantitative research, allowing for a more comprehensive understanding of complex social phenomena. Additionally, critical and post-structural theories have been integrated into qualitative research, enabling researchers to better understand the complexities of power and identity in their work (Denzin& Lincoln, 2011). The fractured future is marked by a growing emphasis on interdisciplinary and collaborative research, as well as a renewed focus on social justice and the ethical considerations of qualitative research (Given, 2008).The main characteristics of this period were:

- Paradigm: Humanistic paradigm
- Ontology: Critical conversations about the diversity
- Methodology: Mixed-method research, moral discourse, the sacred, and critical conversations, including experiences of freedom and control in a global society
- Main contributor researcher: John W. Creswell and many other researchers.

Conclusion

In conclusion, this article provides an overview of the history of qualitative research through eight moments, highlighting the paradigm, ontology, methodology, and significant contributors in each phase. It is clear from the history that qualitative research has undergone many changes over time, from the traditional phase to the postmodern period of experimental ethnography and the fractured future. Qualitative research has gained equal footing with quantitative research in the field of social science research, and researchers are increasingly using a mixed method approach to gain both factual data and emotional feelings. As research continues to evolve, it is essential to keep in mind the history of qualitative research and the contributions made by scholars in this field. Understanding the evolution of research methods helps researchers to make more informed decisions about which approach to use and how to carry out their research.

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Role of remittance in GDP growth of Nepal

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ABSTRACT

This article deals with the analysis of role of remittance in gross domestic production (GDP) growth of Nepal where compression is made with import and export as well. Considering the GDP as dependent variable and the remittance, import and export as the independent variables, the analysis is performed based on the secondary sources of data published by Nepal Rastra Bank (NRB) in last 10 years (2012-2022) and other data available in literatures using the linear models under multiple regressions. The role of remittance has been seen significant effect on the GDP. For the mentioned study period, average GDP growth is 4.49% however it was decreased by 2.36% in the 2019/20. The possible reason of the decrease will be due to the outburst of COVID-19 pandemic worldwide. At the same time, average remittance inflow was 11.09% where it was negative 0.48% in 2020/21. In addition, the flow of remittance is rising, which boosts economic expansion and import volume. Imports make up two thirds of all trade, with exports accounting for the remaining below one third. Economic growth is positively impacted by both imports and exports. When the effects of exports and imports are combined, exports have a negative impact on Nepal's economic growth. Exports have no beneficial effect on economic growth, despite favorable effects from imports.

Key words: remittance, imports, exports and GDP, Remittance and GDP, Inflow

INTRODUCTION

Remittances are a substantial source of foreign cash and are recognized in many developing countries as a crucial tool for decreasing extreme suffering. These involve the distribution of money as a bill, an invoice, or even a gift between parties. However, the term "remittance" is used more widely to describe the money that migrants send to their family members while working and living abroad. Transfers of workers or migrants are other names for them. Due to the rising opportunities for foreign labor and population mobility, the countries have recently witnessed an upsurge in remittances. Given the increase of remittances, it is not surprising to observe how they impact the economies of underdeveloped countries. This raises the issue of how effectively policymakers should use significant inflows of cash. Since developing countries' main objectives are strong and sustained economic growth, it is crucial to assess the value of remittances for these countries in terms of how they influence the recipient's economic situation.

The total monetary worth of all the goods and services produced inside a nation's boundaries over a given time period is known as the gross domestic product (GDP) of that nation. Although GDP is typically measured annually, it can also be calculated quarterly. For instance, the US government releases its GDP on a regular and annual basis. The GDP is sometimes seen as a scorecard for a country's economic health because it gives a comprehensive gauge of a nation's output. Remittances, exports, and imports all contribute significantly to the GDP growth of developing nations like Nepal.

A country has a trade imbalance if the value of its imports exceeds the value of its exports. Most of the time, countries will import goods or services if their own industry cannot do so efficiently or cheaply in the exporting country. In addition, if a country's borders prohibit the import of a good or a raw resource, it may import them. As an illustration, many countries import oil because they cannot produce it domestically or because there is not

enough supply to meet demand. Frequently, free trade agreements and tariff schedules list the goods and commodities that are less expensive to import. Which products and resources are less expensive to import frequently depends on free trade agreements and tariff schedules. The benefits and drawbacks of imports are disputed by economists and policy specialists.

Remittances, according to the World Bank (2021), typically lower the level and severity of poverty, which has positive effects like increasing human capital accumulation, improving health and education spending, improving access to information and communication technologies, boosting small business investment, improving preparedness for adverse shocks like natural disasters, and contributing to a decrease in child labor.

Solimano (2003) had a similar viewpoint when he claimed that remittances function as a beneficial instrument for the growth and development of recipient countries due to their influences on consumption, investment, growth, and savings.

Musaduzzaman(2014)conducted a study on Bangladeshi workers that found a long-term positive association between remittance inflow and gross domestic product, showing that remittances are more likely to contribute to Bangladesh's longer-term economy. Remittances are also shown to have a considerable positive impact on GDP and financial growth. The ratio of bank deposit credit to the private sector and the money supply to GDP are both used in the study to examine the relationship between financial development and remittance inflow. It turns out that remittances have a very good impact on economic growth. The surge in domestic spending brought on by trade surpluses displaces resource allocation and appreciates real exchange rate in a small dependent country was studied by Salter and Swan (Salter 1959; Swan 1960). According to Javaid (Javaid 2011), remittances would result in a significant cash inflow, which will eventually lead to the spread of the Dutch Disease throughout the nation. Remittances may also be referred to as "capital influx," "private help," and other words. Different terms are the result of various studies. Remittances are viewed in our study as "resources (labor) revenue" from overseas.

Lartey, Mandelman and Acosta 2012, According to the argument, as remittances are sent into the country, more money is available to spend and the demand for both tradable and non-tradable items would rise. As a result, "spending effects," one of the Dutch Disease phenomena, will occur. Prices will rise when demand for both tradable and non-tradable goods is higher. Due to the rise in prices, the country's ability to compete internationally in the commerce sector may be jeopardized because domestic customers are more likely to purchase foreign imports that are significantly less expensive than domestic goods. In a case study of Pakistan, Ahmed and Muhammad (Ahmed and Muhammad2009) discovered that the early 1980s, notably 1982–1983, coincided with a strong inflow of remittance from the Middle East and saw the highest induced growth rate by remittance to production growth.

While the micro economy focuses on using remittances for family social security, consumption, and investment at the home and community level, the macroeconomic base primarily focuses on the GDP, including foreign reserve and balance of payment, capacity to import products, etc. Remittances sent by foreign migrants are a relatively reliable source of income, according to the study.

Pant 2013,conducted research on utilizing remittances in Nepal for productive purposes and discovered that remittances increased from Rs47.5 billion in 2001/02 to Rs142.7 billion in 2007/08. Furthermore, the proportion of remittances received through the authorized method has been increasing. Similar to this, the percentage of remittances to GDP ratio climbed from 10.3% in 2001/02 to 17.4% in 2007/08. In this regard, an analysis of the contribution of remittances to GDP growth in relation to imports and exports was made. This study's major goals are to examine how remittances contribute to Nepal's GDP growth and to examine how imports, exports, and remittances relate to GDP.

Neupane (2011) According to the study, remittances are important for raising both domestic consumption spending and a country's GDP. Yet, since a major amount of remittances were spent on the unproductive sector, remittances have decreased domestic investment in the country.

Malekoo (2015), The gross domestic product and the total amount of commercial banks' deposits are positively and significantly impacted by remittance inflow. The study also reveals that consumption and capital formation formations significantly and favorably affect the nation's GDP.

According to International Monetary Fund (IMF 2018) remittances refers to income of household from the temporary or permanent movement of people to those economies. Remittances include cash and noncash items that flow through normal channels, such as via electronic wire, or through informal channels, such as money or goods carried across borders. The largely consist of funds and noncash times or sent or given by individual who have migrated to a new economy and become residents there, and the net compensation of border, seasonal, or other short-term workers who are employed in an economy in which they are not resident”(IMF, 2006). Few researchers also supported the positive relationship between remittances and financial development tends to improve the economy in the home country (Chowdhury, 2011; Aggarwal, Demirguc- Kunt&Peria 2011, Giuliano, Ruiz-Arranz, 2009). A sound institution environment also plays an important role on attracting investment and securing the financial sector as well as quality of services. It then encourages the household to the use of their saving for investment purpose (Catrinecu, Leon- Ledensma, Piracha, Quillin, 2009). However, increase in remittances inflow might deteriorate the institutional quality (Abdih, Chami, Dacher, Montiel, 2011). The inflow of remittances may have a broad effect on the decision of recipients about labor market participation, consumption, investment, education, migration, and shelter with potential implication for the country's long run economic performance (Repo port and Daiquiri, 2005, p.6). Remittances have a direct effect on recipient through serving as a source of income, regardless of the motives of the remitter.

However, remittances inflow has raised up the concern of losing competitiveness in international market will stunt the economic growth in long term. Economist pointed out the possibility of the countries to behave like “youngster” nowadays which is “enjoyed first, suffer later”.

RESEARCH METHODOLOGY

The analysis is based on secondary data that was gathered from Nepal Rastra Bank annual reports from 2012 to 2021. An analysis of secondary data used a descriptive research strategy. For additional model description, statistical tools including mean, standard deviation, correlation, and regression were used. For data analysis, MS Excel and SPSS are used. The research mentioned above provides a model equation. The equation explains the relationships between the dependent and explanatory variables. The study uses linear and multivariate models to investigate the relationships between dependent and independent variables.

$$GDP = \alpha_0 + \alpha_1 REM + \alpha_2 EXP + \alpha_3 IMP + U$$

Where, IMP= Import

REM= Remittance

EXP = Exports

GDP = gross Domestic Product

U = Error term

$\alpha_0, \alpha_1, \alpha_2, \alpha_3$ are the coefficients.

RESULT AND DISCUSSION

To explore the role of remittance for GDP growth in Nepal, relationship between the dependent and independent variables are analyzed. The collected data were tabulated for further comparison. Table 1 show the result based on available data. In table 1, the percentage change of GDP from year 2012/13 to 2021/22 is shown in second column and the corresponding change in the remittance, imports and exports were presented in third, fourth and fifth column, respectively.

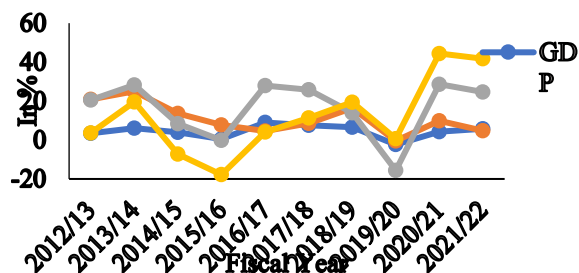
Table 1. Yearly Percent change of variables from 2012/13 to 2022

Year	GDP	Remittance	Imports	Exports
2012/13	3.52515	20.86675	20.5933	3.57666
2013/14	6.01148	25.01541	28.3122	19.5982
2014/15	3.97605	13.61780	8.44363	-7.2532
2015/16	0.43311	7.74132	-0.1401	-17.818
2016/17	8.97728	4.56920	27.9879	4.18144
2017/18	7.62238	8.57085	25.7536	11.3769
2018/19	6.65706	16.45075	13.9291	19.3581
2019/20	-2.3696	-0.48272	-15.631	0.61743
2020/21	4.24694	9.83142	28.663	44.4329
2021/22	5.83752	4.81266	24.7176	41.7412
Average	4.49173	11.099344	16.2629	11.9812

Source: NRB annual reports

In the table 1, GDP is 3.525 in the year 2012/2013 and increases to 6.011 in the year 2013/2014. Similarly, it decreases in the two year 2014/2015 and 2015/2016 with 3.97 and 0.433 respectively. There is a little bit fluctuation up to the year 2018/2019 but in the year 2019/2020 due to the pandemic of COVID 19, the GDP is negative i.e. -2.369. Similarly, the average GDP is 4.491. The remittance is 20.866 in the year 2012/2013 and fluctuations are seen up to the year 2018/2019. Similarly in the year 2019/2020 there is seen negative in the remittance i.e., -0.482 due to the COVID 19 outbreak. The average remittance is 11.099%, average imports are 16.26% and average exports is 11.98% in the study period. There is seen negative in the year 2015/2016 i.e., -0.14. Moreover, there are seen fluctuations in the remaining year except in the year 2015/2016 and 2019/2020. The average value of exports is 11.98. The highest value of exports is 44.43 in the year 2020/2021 and lowest value of exports is -17.81. The figure 1 clearly shows the fluctuations and relationships of variables.

Figure.1 Variables' percentage changes during the previous ten years.



Source : NRB annual report analysis

The correlations between the variables are shown in the table 2 below. The correlation coefficient between exports and import is positive and moderate degree which is 0.60. The correlation between export and GDP is positive degree 0.67, the correlation between exports and remittances is positive and low degree i.e. 0.05. Similarly, the correlation between imports and GDP has high degree of relation which is 0.86. The correlation between imports and remittance also has positive and moderate relationship which is 0.41. And lastly remittance and GDP has positive relation.

Table .2 Correlations between variables.

	<i>GDP</i>	<i>Remittance</i>	<i>Imports</i>	<i>Export</i>
GDP	1			
Remittance	0.2897068	1		
Imports	0.8617577	0.412275	1	
Export	0.3943043	0.050123	0.602102	1

Source: researcher's analysis

The correlation coefficient between the imports and GDP is very high degree. The correlation between remittance and exports is low degree of positive. It is usual looking to the effect of the remittance. Due to the increment in total remittance the imports, exports of the selected study period is increased when there is increase in remittance. Due to the increment in total remittance that is simultaneously increasing the total trade, import and exports. This increment in the total remittance is increase than reduce the poverty and increase the GDP. Represents the regression result of the effect of remittance, imports, and exports on GDP. The value of R square indicates 0.7811 which is 78.11% of the variance in the dependent variables that the independent variables are explained by the model.

Table .3Impact of Regression on imports, exports and remittance with GDP

R	R Square	Adj. R Square	Std. Error	F	Significance F	p-value
0.883809	0.781118	0.671677	1.943506	7.13733	0.0209653	0.203092

Source: Calculation of data

The independent variable along with constant term is statistically significant at five percent level. The adjusted coefficient of determination ($Adj. R^2$) is 0.6717 which is 67.17% and it shows that the model is fit which means that dependent variable GDP depend on import, remit, and exports 67.17 percent and remaining 32.83 percent others. The F-statistics shows the overall fitness of the model. The value of F is high and its p value is statistically significant at 5 percent. The coefficient is 2.15 which show one percent increase in the real import whereas, exports and remit increases real GDP by 2.15 percent.

The coefficient of GDP is positive and significant, meaning that increases in the real import trade increases economic growth in Nepal. The positive and significant coefficient confirms that real imports cause the economic growth to rise. The positive value of independent variables and GDP indicates country imports of raw material, technology, human capital etc. and these factors contribution domestic economy.

CONCLUSION

The study was conducted to analyze the role of remittance in GDP growth with the help of secondary data. Domestic data sets published by Central Bureau of Statistics (CBS) Nepal from its National Accounts Section are collected for the period 2012/13 to 2021/22. The coefficient of remit is positive, meaning that increases in the real total trade which increases economic growth in Nepal. The positive coefficient confirms that remit causes the economic growth to rise. Due to the increment in total remittance, there simultaneously increase in the import and

exports. This increment in the total remittance reduces the poverty and increase the GDP. The study reveals that economic growth is low and unstable in Nepal. Real imports trade is increasing very fast whereas real exports are not following import trends.

The results infer that Nepalese economy is dominated by import trade. Import substitution policies are now also a remedy for Nepalese economy. At least basic goods should be sufficiently produced at the domestic level so that imports are sustainably reduced. Export competitiveness is too weak for Nepal economy. Therefore, trade as well as production policies should be linked to export promotion. To utilize remittance in long term investment government should priorities the remittance income for investment and should be applying policy to maximize consumable goods production.

Recommendation

Most of the part around 95 percent of remittances is only spent on daily consumption by earning group so government should formulated saving increasing policy. The results infer that Nepalese economy is dominated by import trade. Import substitution policies are now also remedy for Nepalese economy. At least basic goods should be sufficiently produced by domestic level so that imports are sustainably reduced.

Export competitiveness is too weak for Nepal economy. Therefore, trade as well as production policies should be linked to export promotion. The results infer that Nepalese economy is dominated by import trade. Import substitution policies are now also remedy for Nepalese economy. At least basic goods should be sufficiently produced by domestic level so that imports are sustainably reduced.

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Mathematical Modeling of Communicable Diseases with Yoga as Control Strategy

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Abstract

The purpose of this paper is to formulate and analyze the abstract behavior of diseases dynamics. The formulation of the problem in the paper is inspired by ethnographies from different social setting and ancient cultural practices related to human health problems. Many people have been worried for communicable diseases caused by virus due to their complexities and dearth of knowledge. They have been a major cause of morbidity and mortality among humans all over the world. Yoga Sadhak compartment (Y) is added to SIR model. A new SYIR model is developed which contains four governing differential equations to describe the transmission dynamics of these disease. These equations were analyzed. Effectiveness and efficiency of yoga pranayama is calculated. Reproduction number is estimated and sensitivity analysis of parameters used in the model is studied. A distinction is made between infection in naïve susceptible and Yoga Sadhak susceptible individuals. Using the model, association between prevalence of infection and immunity by Yoga Pranayama is analyzed. It is found that Yoga Pranayama induce immunity power in individuals which help to reduce transmission rate of diseases. The model shows that eradication depends on Yoga Pranayama coverage as well as on yoga Pranayama efficacy. This study definitely answers the questions regarding the effectiveness of Yoga Pranayama. Further studies are needed to formulate the model and establish causal relationship between parameters involved in the model.

Key Words: Transmission dynamics, Pranayama, Immunity power, Epidemic equilibrium.

Introduction

Background of study

Mathematical modeling is powerful tool of scientific method in which we identify a real world and a conceptual world. In Real world, (we call external world) in which we observe various phenomena and behaviors in their natural form or produced by artifacts. The conceptual world is the world of the mind where we live when we try to understand what is going on in that real (external) world. The conceptual world can be viewed as having three stages: observation, modeling and prediction. In the observation part of the scientific method we measure what is happening in the real world. We gather empirical evidence and facts on the ground. Observations may be direct where we use our senses or indirect in which case some measurements are taken to indicate through some other reading that an event has taken place. Mathematical models describe the behavior or results observed, explain why that behavior and results occurred or allow us to predict future behaviors or results that are yet unseen or unmeasured. In the prediction part of the scientific method, we exercise our models to tell us what will happen in a yet to be conducted experiment or in an anticipated set of events in the real world. These predictions are then followed by observations that serve either to validate the model or to suggest reasons that the model is inadequate. We build models and use them to predict events that can confirm or deny the models (Antman et al., 2003; Elizabeth S. Allman; John A. Rhodes, 2004; Welty et al., 2016).

Communicable diseases have been a cause of global concern throughout the history of mankind. Its outbreak affects the morbidity and mortality rates across the world. Daniel Bernoulli (1760) formulated and solved a mathematical model for smallpox. In his model, he evaluated the effectiveness of vaccination inoculating healthy people against the smallpox virus. The conclusions from this model showed that universal inoculation against smallpox would increase the

life expectancy from 26 years 7 months to 29 years 9 months (Moore et al., 2020; Sangam et al., 2015). Hamer 1906 formulated and analyzed a discrete-time model for measles. Hamer proposed that the spread of infection should depend on the number of susceptible individuals and the number of infective individuals. Ross developed a differential equation model for malaria a vector-borne disease. Dr. Ross was awarded the second Nobel Prize in Medicine for his demonstration of the dynamics of the transmission of malaria between mosquitoes and humans. Kermac and Mc Kendrick extended Rosse's model for plague studied in Mumbai in (1926) and obtained the epidemic threshold results. This model also gives the relationship between susceptible, infected and recovered. Lotka (1913) and Volterra (1926) proposed the predator-prey model. Reed-Frost (1928) describes the relationship between susceptible, infected, and immune individuals in a population. Hethcote H.W. (1976-1980) developed SIS, SIR model for communicable diseases with vital dynamics and without vital dynamics and published various papers (Day, 2009; Martcheva, 2013; Mathematics, 2008; Pokharel, 2020; Sangam et al., 2015).

Epidemiology describes patterns of health, illness and associated factors at the population level. The word "epidemiology" is derived from the Greek terms epi, which means "upon," demos, which means "people," and logos, which means "study." This etymology implies that the subject of epidemiology applies only to human populations. The role of father of epidemiology is often assigned to the Greek physician Hippocrates (460–377 B.C.E.), who described the connection between disease and environment. The term "epidemiology" appears to have first been used to describe the study of epidemics in 1802 by the Spanish physician de Villalba in *Epidemiologia Espanola* (Martcheva, 2013). Epidemiological studies were mostly concerned with infectious diseases. But nowadays, a central concern of epidemiology is to study diseases such as stroke and coronary heart disease, positioning diseases that do not transmit from one person to another as infectious diseases. These diseases are dominating worldwide spreading infectious disease such as pneumonia, dengue, influenza and HIV (Martcheva, 2013; Pokharel, 2020). Epidemiology is a branch of medical science dealing with disease incidence, distribution and control in a population. It identifies risk factors, assesses treatment and health services modalities, and provides opportunities for the prevention, treatment, planning and improvement of health services effectively. The ultimate aim of any epidemiological study is to eliminate or reduce health problems thereby promoting the health and well-being of the society as a whole. Epidemiological studies are useful because it provides relevant information on disease in a given population, facilitates diagnosis of disease at a community level, promotes planning and evaluation of health care facilities and programs and risk assessment of individual. Epidemiology provides a framework to endure the basic tenet of addressing the determinants of infectious diseases and its distribution in specified population and helps in the control of health related problems (Mathematics, 2008).

The term yoga is derived from Sanskrit root yuj which means contemplation (Samadhi; trance) and is characteristics of the mind pervading all its planes. It is a psycho-somatic spiritual discipline for achieving union and harmony between our mind (puroosh) and body (prakriti) and the ultimate union of our individual consciousness with the universal consciousness. It is mind-body cinque which involves relaxation, meditation and a set of physical exercises performed in sync with breathing. It is the best means for achieving physical, mental, social and spiritual well being of the practitioners. This can be achieved by systematic and disciplined practice of ashtang (eight-limbed) yoga described by sage Patanjali. The eight limbs of yoga are yama (abstinences), niyama (observances), asana (yoga postures), pranayama (breath control), pratyahara (withdrawal of the senses), dharana (concentration), dhyana (meditation) and samadhi (absorption). The first two limbs yam and niyam which are ethical code and personal discipline for the development of our moral, spiritual and social aspects. Third and fourth limbs asana and pranayama help in our physical development and improvement of physiological functions. Fifth and sixth limbs pratyahar and dharna controls our senses and making our mind one-pointed, calm and alert. The final two limbs dhyana and samadhi result in inner peace, ecstasy, higher level of consciousness and the ultimate union of our individual consciousness with the universal consciousness resulting in realization of power of the universe. The result is unfoldment of a unique spiritual personality that is a blessing for the whole humanity (Maehle, 2012; Ushar Buddh Arya, 1986; Yogini, 2006). Yoga helps in developing our total personality in an

integrated and holistic manner. In this paper fourth limb of Yoga Pranayama is considered as control strategy of Communicable diseases. This fourth Anga or limb of Ashtanga Yoga Pranayama regulates breath or controls Prana by stopping of inhalation and exhalation, which follows after securing that steadiness of posture. Healthy life can be considered as a by-product of practicing yogic techniques since it has been observed that yoga practitioners are physically and mentally healthier and have better coping skills to stressors (victim) than the normal population (Ann Swanson, 2019; Clennell, 2007; Maehle, 2012). So Yoga is widely practiced and globally accepted health promoting tool in our society. Healthy people as well as patients may inquisitively approach medical professionals to take consultation about Yoga. If this knowledge about yoga invokes interest in the medical professionals and they practice it themselves, it might open up new avenue in bringing together our traditional heritage of yoga and today's objective knowledge of modern medicine. Documented scientific evidence strongly indicates that yoga has promotive, preventive as well as curative potential. It can be used as an effective lifestyle adjunct to medical treatment to reduce drug dosage and improve quality of life of the patients. It is to be emphasized that yoga is very effective for prevention as well as management of all pervading health problems and health-related disorders. Modern medicine is very effective in controlling infections, performing surgeries and managing diseases. However, it has limited role in controlling infectious diseases caused by virus, stress-based diseases, chronic degenerative, old age and lifestyle related disorders which are the bane of modern society. Yoga has been found to be very effective in these conditions. Our public health delivery system is under-staffed, fund-starved and reeling under severe economic burden. Knowledge of inexpensive, effective and easily administrable yogic techniques will go a long way in helping us to achieve the WHO goal of providing "Physical, mental, spiritual and social health" to the society (Estrada-hernandez, 2020). Yoga can help to regulate enzymes, increase immunity and maintains three imperfections Kaph, Bata and Pitta (Swami Satyananda Saraswati, 1995). So professionals are seeking to establish Yoga Pranayama as an independently viable healing practice as well as integrate it into the current modern medical model. It will aid health care providers and fitness professionals in recommending the most beneficial yoga practice to their patients'. It can have a clearly positive influence, where disease propagation is minimized or fully stopped (Sardhana & Singh, 2016; Swami Satyananda Saraswati, 1995). Research has been completed in various fields of yoga, Mathematical modeling of communicable diseases with Yoga as control strategies has not been studied yet. In this paper we try to solve such problem.

Methodology

We construct a deterministic mathematical model using a system of ordinary differential equations where the total population, denoted by $N(t)$, is divided into four mutually exclusive sub-populations according to their epidemiological (or disease) status: susceptible, Infected and infectious, Yoga Sadhak and recovered. We analyze the model qualitatively to determine the criteria for containing an epidemic/pandemic of communicable disease like influenza, COVID-19 with the presence of Yoga Pranayama. Epidemic threshold is computed. A sensitivity analysis on the key parameters is also performed. Variables /Parameters are numerically analysed.

We evaluate the possibility that the disease may take-off in the absence of Yoga awareness and classical basic reproduction number denoted by R_0 is calculated. With this threshold, the qualitative mathematical properties of the model are studied, and the epidemiological consequences are discussed. If the parameter R_0 is less than unity ($R_0 < 1$), then the disease cannot spread in the population but, if $R_0 > 1$, then, the spread of the disease in the population is always possible. R_0 is calculated using the next generation operator method. This epidemiological quantity measures the average number of new cases generated by an infectious individual for the duration of his/her infectiousness in a completely susceptible population.

Formulation of model

We divide the total population (N) into four classes to build the model. Namely, S_1 the naive susceptible individuals (non-Yoga Sahak); Y_1 the Yoga Sadhaka individuals performing Pranayama which produce immunity and lost after a certain period of time if practice is left.; I_1 infected individuals which contain both infectious Yoga Sadhak and non-Shadak.

Finally R_1 the recovered individuals. The model contains constant population and considered that the natural mortality rate and natural death rate are constant so that it balances the total population to be of constant size N . Interaction occurs between the classes as they mix with each other naturally. Interested non-Yoga Sadhaka susceptible individuals S_1 are shifted to Yoga Sadhaka class Y_1 at a rate m if they perform yoga Pranayama daily. The naive susceptible individuals S_1 become infectious and move to class I_1 . The incidence is the infection rate of susceptible individuals through their contact with infective such that the number of primary infectious individuals produced by adequate contact $\frac{\beta S_1 I_1}{N}$ where β is the transmission coefficient of the disease infection of non- yoga Sadhaka individuals. It is realistically assumed that the Yoga Pranayama induces protection from natural infection and the immunity so induced produce a class of Yoga Sadak susceptible individuals Y_1 . These susceptible individuals develop immunological memory. So they are able to elicit very quickly an immune response, so their infection rate is lower than that of the naive susceptible individuals S_1 or they have no infection. In such a situation, the number of new infectious produced by adequate contacts is $\frac{\rho_1 Y_1 I_1}{N} N$ where $\rho_1 = \sigma\beta$ is the transmission coefficient of the disease infection in Yoga Sadhaka and $0 \leq \sigma \leq 1$. Parameter σ illustrates the effect of immunity produced by Yoga Pranayama, so it is the factor that reduces the risk of infection and reinfection. if $\sigma = 0$, then, the Yoga Pranayama is useless and if $\sigma = 1$, the Yoga Pranayama is 100% effective, From now on we make the realistic assumption that Yoga Pranayama brings out immune response, but it fail to offer long-lasting protection against infection and reinfection, that is, $0 < \sigma < 1$. Induced immunity against infection are assumed to be lost at per capita rate ρ_2 . Thus, after recovery, they may have chance to become infected. ρ_1 is the rate at which the Yoga Pranayama sadhak become infected and move to infected class and ρ_2 is the rate at which the recovered individuals (natural protection decreases) again move to susceptible class. The average duration of immune protection acquired either by Pranayama or infection is $d_2 = \frac{1}{\rho_2}$. This duration is predicted to evolve asymptotically towards infinity in reality it is of course finite. The model assumes that infectious individuals recover with rate constants $\gamma > 0$. The recovering period of the Yoga Sadhaka infectious individuals may be shorter than that of the non-Yoga Sadhaka one. But here we take average recovery period. The recovered individuals move back to classes S_1 by decreasing protection. Finally, we assume that individuals may either inter to Yoga Sadhaka Class Y_1 at same rate m or remain to class S_1 .

Variables and parameters so defined are given in the following table.

Variables/Parameters	Description
$S_1(t)$	Naive susceptible individuals at time t
$Y_1(t)$	Yoga Sadhak class at time t
$I_1(t)$	Infected(infectious) class at time t
$R_1(t)$	Recovered class at time t
Λ	Recruitment rate of individuals into the population
β	Disease transmission rate i.e. Contact rate
γ	Recovery rate
σ	Yoga Pranayama efficacy ($\sigma \in [0, 1]$)
m	Rate at which susceptible individuals are becoming Yoga Sadak
ρ_1	Rate at which the Yoga Sadhak become infected ($\rho_1 = (1 - \sigma)\beta$)
ρ_2	Rate of wanning immunity induced by infection

The model is governed by the system of ordinary differential equations:

$$\frac{dS_1}{dt} = \Lambda N - \beta \frac{S_1 I_1}{N} - (m + \mu)S_1 + \rho_2 R_1$$

$$\frac{dY_1}{dt} = mS_1 - \frac{\rho_1 Y_1 I_1}{N} - \mu Y_1$$

$$\frac{dI_1}{dt} = \frac{\beta S_1 I_1}{N} + \frac{\rho_1 Y_1 I_1}{N} - (\gamma + \mu)I_1$$

$$\frac{dR_1}{dt} = \gamma I_1 - (\rho_2 + \mu)R_1$$

Non-negative initial conditions are $N(0) > 0$ and $S_1 + Y_1 + I_1 + R_1 = N$

Above System is well posed, since solutions remain non-negative for non-negative initial conditions. The demographic equation for the dynamics of the total population size remain constant as birth rate is considered equal to death rate. So that the total population remains constant N . Since the model is homogeneous of degree one, the variables can be normalized by setting

$$S = \frac{S_1}{N}, Y = \frac{Y_1}{N}, I = \frac{I_1}{N}, R = \frac{R_1}{N}$$

It leads to the following normalized system of ordinary differential equations.

$$\frac{dS}{dt} = \Lambda - \beta SI - (m + \mu)S + \rho_2 R$$

$$\frac{dY}{dt} = mS - \rho_1 Y I - \mu Y$$

$$\frac{dI}{dt} = \beta SI + \rho_1 Y I - (\gamma + \mu)I$$

$$\frac{dR}{dt} = \gamma I - (\rho_2 + \mu)R$$

Where each variable denotes a fraction of the total individuals so that

$S + Y + I + R = 1$. This is illustrated in following diagram

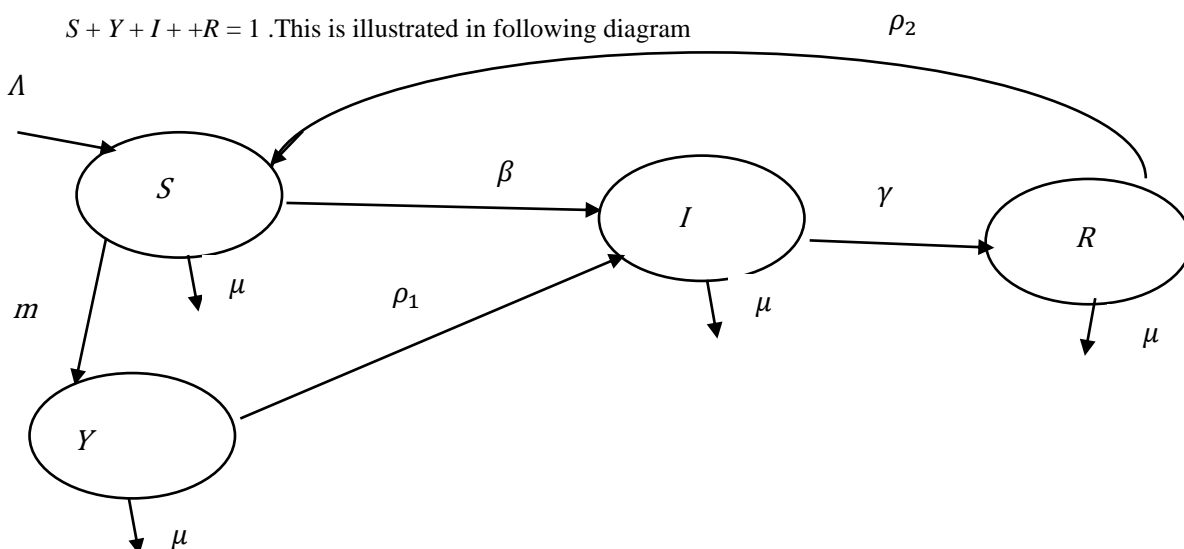


Figure 1: The flow diagram for the SYIRS model

Result

Analysis of Model

Above Systems includes modeling equations of transmission dynamics of communicable diseases which predicts diseases control strategy and changes in qualitative behavior of people by performing Yoga Pranayama To develop the framework for predicting disease control strategy yoga classes, Yogachautari, online classes, yogachamp etc. are conducted and yoga sadhak whose are conducting yoga regularly for long time are considered. The systems of equations together with these yoga schedules will be qualitatively analyzed so as to find the conditions for existence and stability of a disease free equilibrium point. The analysis allows us to determine the optimal yoga coverage level needed for disease control and to find the basic reproduction number denoted by R_0 in mathematical epidemiology which is the average number of infected individuals produced by one infected individual introduced in a population completely susceptible. Thus, if $R_0 < 1$, the disease dies out and if $R_0 > 1$, the disease spreads in the population and goes to an endemic level. For a disease that confers immunity in which the susceptible population is yoga sadhak, it has been demonstrated that under certain parameter conditions there is a dependence of the reproductive number on the pranayama rate. In such a case, the reproduction ratio R_p which is the basic reproduction ratio R_0 modified by pranayama must be reduced below one in order to ensure that the disease dies out. If there is no yoga sadhaka performing pranayama, then $R_p = R_0$. Therefore the aim of the yoga campaigns against communicable diseases must be to reduce R_p below one and to provide prolonged protection against both clinical disease and natural infection and reinfection.

Positivity and boundedness

The variables involve in the model must be positive and bounded. We first assume that all the parameters in the model are positive.

From above first equation

$$\frac{dS}{dt} = \Lambda - \beta SI - (m + \mu)S + \rho_2 R \geq 0$$

$$\frac{dS}{dt} \geq -\beta SI - (m + \mu)S$$

$$S = S_0 \exp \left(- \int_0^t (\beta I + m + \mu) dt \right)$$

This means $S \geq 0$ Similarly $I \geq 0$; $Y \geq 0$; $R \geq 0$

Adding all above equations; $\frac{dS}{dt} + \frac{dY}{dt} + \frac{dI}{dt} + \frac{dR}{dt} = 0$

On integrating, we get $S + Y + I + R = 1$. So the system is bounded.

Reproduction Number

Basic Reproduction Number

The concept of basic reproduction number R_0 introduced by Ross in 1909 is defined in epidemiological modeling as the average number of infected individuals produced by one infected individual introduced in a population completely susceptible. The basic reproduction number (R_0) is used to measure the transmission potential of a disease. For example, if the R_0 for measles in a population is 12, then we would expect each new case of measles to produce 12 new secondary cases (assuming everyone around the case was susceptible). R_0 excludes new cases produced by the secondary cases.

Effective Reproduction Number

A population will rarely be totally susceptible to an infection in the real world. Some individuals will be immune due to prior infection which has conferred life-long immunity, or as a result of previous immunization or some protective majors. Therefore, all individuals will not become infected and the average number of secondary cases per infectious case will be lower than the basic reproduction number. The effective reproductive number (R_e) is the average number of secondary cases per infectious case in a population made up of both susceptible and non-susceptible hosts. Effective reproduction number is the number of people in a population who can be infected by an individual at any specific time. It changes as the population becomes increasingly immunized, either by individual immunity following infection or vaccination or Yoga. if $R_e < 1$, the disease dies out and if $R_e > 1$, the disease spreads in the population and goes to an endemic level such as at the start of an epidemic.

Where $R_e = 1$, the disease is endemic. Mathematically the basic reproduction number is defined as

$$R_0 = \frac{\text{Contact Rate}}{\text{Recovery Rate}} = \frac{\beta}{\gamma + \mu}$$

We use next generation matrix to find effective reproduction number. From next generation matrix the reproduction number is given by

$$R_e = \frac{\beta S_0 + \rho_1 Y_0}{\gamma + \mu} = \frac{\beta S_0 + (1 - \sigma)\beta Y_0}{\gamma + \mu} = \frac{\beta - \sigma\beta Y_0}{\gamma + \mu} = \frac{\beta(1 - \sigma Y_0)}{\gamma + \mu} = R_0(1 - \sigma Y_0)$$

$$\therefore R_e < R_0$$

If there is no Yoga Sadhaka, then $Y_0 = 0$ and hence $R_e = R_0$. This relation indicates that the more people who are Yoga Sadhak, the less value of R_e . This implies that Yoga Pranayama decreases the value of reproductive number, hence controls the disease. So Yoga Pranayama is effective in controlling the communicable diseases.

Sensitivity Analysis

Mathematical models are widely used to examine, explain and predict the dynamics of infectious disease transmission. Sensitivity analysis characterizes the response of model outputs to parameter variation, helping to allocate resources to follow-up experimentation and field study. Sensitivity analysis enables us to ascertain the effect of a particular parameter in the model on dependent variable.

The sensitivity index on R is given by

$$A_p = \frac{\partial R}{\partial P} \frac{P}{R} \text{ Where } R \text{ is reproduction number and } P \text{ is parameter of interest.}$$

(a) sensitivity of β on R_e

$$A_\beta = \frac{\partial R_e}{\partial \beta} \frac{\beta}{R_e} = 1$$

This indicates that there is direct relation between R and β .

(b) Sensitivity of σ on R_e

$$A_\sigma = \frac{\partial R_e}{\partial \sigma} \frac{\sigma}{R_e} = \frac{1}{1 - \frac{1}{\sigma Y_0}} = 1 + \frac{1}{\sigma Y_0} + \frac{1}{\sigma^2 Y_0^2} > 1$$

Which is also positive and greater than 1 which indicates that R_e is directly related to σ .

(c) Sensitivity Analysis of γ on R_e

$$A_\gamma = \frac{\partial R_e}{\partial \gamma} \frac{\gamma}{R_e} = \frac{-\gamma}{\gamma + \mu}. \text{ Similarly } \mu \text{ has opposite effect.}$$

Stability Analysis

Disease free equilibrium point

The equilibrium condition in the absence of the infection is known as disease free equilibrium condition. S_0 is the initial number of susceptible population and Y_0 is initial number of Yoga Shadhak individuals. At disease free or trivial equilibrium point (DFE), we have $E_0 = (S_0, Y_0, 0, 0)$ with the Jacobin matrix of above system evaluated at the DFE is

$$J_0 = \begin{bmatrix} -\mu - m & 0 & \beta S_0 & \rho_2 \\ m & -\mu & -\rho_1 Y_0 & 0 \\ 0 & 0 & \beta S_0 + \rho_1 Y_0 - \gamma - \mu & 0 \\ 0 & 0 & \gamma & -\rho_2 - \mu \end{bmatrix}$$

Now $\det (J_0 - KI) = 0$

$$\begin{vmatrix} -\mu - m - k & 0 & \beta S_0 & \rho_2 \\ m & -\mu - k & -\rho_1 Y_0 & 0 \\ 0 & 0 & \beta S_0 + \rho_1 Y_0 - \gamma - \mu - k & 0 \\ 0 & 0 & \gamma & -\rho_2 - \mu - k \end{vmatrix} = 0$$

Solving it, we get

$$(-\mu - k(\beta S_0 + \rho_1 Y_0 - \gamma - \mu - k))[k^2 + (2\mu + m - \rho_2)k + (\mu^2 - \mu\rho_2 + m\mu - m\rho_2)] = 0$$

From this we four values of k : $k_1 = -\mu$; $k_2 = \beta S_0 + \rho_1 Y_0 - \gamma - \mu$;

$$k_3 = -(\mu - \rho_2); \quad k_4 = -(\mu + m)$$

Therefore, the system is stable.

Endemic equilibrium point

When the disease is present in the population o then $I^* \neq 0$. There may be several critical points when $I^* \neq 0$, which are the endemic equilibrium points (EEP) of the model. These points will be denoted by

$P^* = (S^*, Y^*, I^*, R^*)$ which are determined from above system as follows

$$S^* = \frac{\mu + \gamma + \beta \sigma Y^* - Y^*}{\beta}; \quad Y^* = \frac{m S^*}{\rho_1 I^* + \mu}; \quad \text{Also } I^* = \frac{(\rho_2 + \mu) R^*}{\gamma} \quad \text{and } I^* = \frac{m S^*}{\rho_1 Y^*} - \frac{\mu}{\rho_1}$$

Numerical Analysis

The numerical analysis of the model was done with the parameters of the model fixed at the values indicated in following table. Also, effect of Yoga Pranayama is calculated.

Symbols	Description of State Variables/ Parameters	Base Value	Reference
μ	death rate	.006232	UN ; world population Prospective
B	Disease transmission rate	0.625	Assumed
Σ	effect of immunity produced by Yoga	$0 < \sigma < 1$ i.e. $\sigma = 0.8$	Assumed
Γ	recovery rate	1/7	Assumed

Symbols	Description of State Variables/ Parameters	Base Value	Reference
Λ	Birth rate	6.232	Assumed
M	growth rate of Yoga Sadak individuals	0.25	Assumed
ρ_1	Rate of wanning immunity induced by Yogai. $e. \rho_1 = (1 - \sigma)\beta$	0.125	Assumed
ρ_2	Rate of wanning immunity induced by infection	0.10	Assumed
$S(0)$	Susceptible population	0.98	Assumed
$I(0)$	Infected population	0.02	Assumed
$Y(0)$	Yoga Sadhak	0.50	Assumed

Table 1: Parameter values used in simulation

We first estimated the reproduction number from the data. $R_0 = 4.2$ and $R_e = R_0(1 - \sigma Y_0) = 2.48$. If Yoga Pranayama Sadhak are 80% or 0.80 and $\sigma = 0.9$, then R_e is nearly equal to 1. In this case disease remain as endemic. If $\sigma = 0.9$ and $Y_0 = 0.90$, then $R_e = 0.798$. In this case diseases is eliminated. Yoga Pranayama is completely effective in controlling diseases.

Conclusion and Discussion

Discussion

This work is based on the formulation and use of a mathematical model for the transmission dynamics of communicable diseases with Yoga Pranayama in a human population. The main part of this work with respect to previous models is that we explicitly consider Yoga Pranayama efficacy where a fraction of susceptible individuals is transferred to Yoga compartment per unit time. Indeed, this model is more appropriate for developing countries where adequate health facilities are not generally available for mass hospitalization, isolation and quarantine. Our proposed incorporates some essential parameters (such as σ, ρ_1) of diseases transmission, which enable the assessment of preventive strategies, and their epidemiological consequences. The model is given in the form of a non-linear ODE, and our analytical results show that the effective reproduction number R_e is reduced whenever Yoga Pranayama is introduced as a control measure (i.e., $R_e < R_0$). Also, the Yoga Pranayama *increases immunity*. Thus, concurrent administration of Yoga Pranayama is more adequate in controlling the epidemic.

This is consistent with the fact that control measures are necessary to reduced the value of the basic reproduction number R_0 , and if this quantity is less than unity, the disease can be eradicated. Thus, a more than 90% Yoga Sadhak are necessary for more effective controlling of the epidemic. Since it is well-known that infected persons also confer immunity which wan with time. After recovering, they may migrate from recovered class to susceptible class, this is incorporated into our model by assuming that they move at a rate ρ_2 .

DFE equilibrium exist and amount of preventive measures can eradicate disease from the population (i.e., prevention is better than cure). We use a continuous Yoga Pranayama program (where a fraction of susceptible individuals move to this class per unit time), We have performed sensitivity analysis on a mathematical model of dynamics of disease transmission to determine the relative importance of model parameters to disease transmission and by computing sensitivity analysis it indices that β, σ, ρ_1 have direct effect on reproduction number of the reproductive numbers where as γ, μ have indirect effect on it.

Conclusion

Mathematical models are potentially useful tools to aid in the design of control programs for communicable diseases. We developed an epidemiological model of transmission dynamics of communicable disease with Yoga Pranayama and used it to predict trends in infection as well as possible control measures. The model incorporates realistic features including Yoga Pranayama compartment of individuals. The qualitative and quantitative mathematical properties of the models are studied, their biological consequences and some control strategies are discussed, and the results of the models are calculated in the presence of Yoga Pranayama that may wane over time. We find that the disease can be controlled by Yoga pranayama and immunity loss can be balanced increasing Yoga practice. The model incorporates the assumption that the disease does not confer permanent immunity by Yoga and infection, thus reinfection is possible. The important observation from our results is that waning of immunity is a major obstacle to the eradication of infectious diseases with just a Yoga Pranayama.

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