Review of Economic Assessment

Homepage: https://www.anserpress.org/journal/rea

Economic impact of All-Terrain Vehicles (ATVs) on local economies: a literature review

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ABSTRACT

The use of All-Terrain Vehicles (ATVs) has gained considerable attention within the recreation industry. The incorporation of ATVs into tourism and recreational activities has demonstrated substantial economic potential for local economies. However, there is a lack of comprehensive knowledge regarding the economic impact of ATV recreation. This paper conducts an extensive review of existing literature from 2004 to 2022, evaluating the economic impact of ATVs on local economies in the United States. The review aims to identify commonalities and disparities among existing economic impact studies and assess whether these studies have included costs associated with ATV-induced environmental, societal, and public health damages in their economic assessments. To this end, there is a scarcity of scientific peer reviewed journal articles that exclusively focus on the economic impact of ATVs. As such, we reviewed a total of seven publications comprising reports. The results of our analysis shed light on similarities and differences in aspects of resident and non-resident ATV spending, type of ATV expenditures, and the approaches used to evaluate economic impact assessment. The findings indicate that existing studies have assessed the economic impact of ATVs solely based on gross expenditures, lacking comprehensive inclusion of the costs associated with ATV damages to the environment, society, and human health. This study advocates for the need for a more comprehensive consideration of both benefits and costs in the economic impact of ATVs to assist ATV business managers, policymakers, and researchers in making informed decisions and planning future programs.

KEYWORDS

Off highway vehicle; off road vehicle; outdoor tourism recreation; environmental cost; impact assessment

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ISSN 2972-3515
doi: 10.58567/rea03010003

Received 11 October 2023; Accepted 26 February 2024; Available online 1 March 2024

1. Introduction

Off-highway vehicles (OHVs) represent a prevalent form of recreational activity in the United States, encompassing a variety of vehicles including, All-Terrain Vehicles (ATVs), snowmobiles, dirt bikes, Utility Terrain Vehicles (UTVs), and other four-wheel-drive vehicles. This review specifically focuses on ATVs, widely regarded as one of the most favored OHVs for recreational purposes (Balthrop et al., 2009). Characterized by low-pressure tires, operator seating, and handlebar steering, ATVs are designed for use across diverse unpaved terrains, finding applications in both recreational and agricultural domains. In recreational contexts, they are utilized for activities such as trail riding, racing, and hunting, while in agriculture, they contribute to functions such as farming, ranching, and wildlife management (Chou et al., 2022).

ATVs were initially introduced to the US market in the early 1970s as a solution for efficient on-farm transportation in agricultural industry (Fonseca et al., 2005). Since then, they have experienced a substantial increase in demand and usage (Schneider and Schoenecker, 2006). Data from the ATV Safety Institute (2005) reveals that in 2005 alone, 15 million US residents engaged in ATV riding. By 2009, ATVs had ascended to become the most licensed OHV in Michigan (Nelson et al., 2010). The global market value for ATVs in 2020 amounted to $3 billion, with North America alone accounting for $2 billion. Projections indicate an annual growth rate of 7% between 2021 and 2027 (Wadhwani and Saha, 2021). As the popularity and prevalence of ATVs continue to thrive worldwide, their potential to confer substantial economic advantages upon local communities and national economies becomes increasingly evident (Schneider et al., 2009).

ATV tourism emerges as a valuable investment for local economies (Perry, 2016). It creates job opportunities in manufacturing and sales industries, boosts tax revenue, and contributes to the local and state economies, as well as the nation's Gross Domestic Product (GDP). ATV investments begin with the purchase of ATVs and continue with expenditures related to maintaining and operating vehicles accompanied by other rider-related and ATV-related expenses such as permit fees. The potential economic benefits of ATVs are being recognized in many regions around the world (e.g., the US, Australia, and Canada), leading to increased tourism development efforts globally.

A thriving ATV market is not without its drawbacks. The increased use of ATVs is associated with a range of adverse impacts on the environment, society, and human health. Environmental impacts include damage to soil and vegetation on the landscape, air pollution from vehicle emissions, harm to water quality, trail surfaces, and wildlife as well as noise pollution (Fonseca et al., 2005; Bissix and Medicraft, 2008; Khorsandi et al., 2023). ATVs can create conflicts with other recreational activities such as hiking and cross-country skiing (Bissix and Medicraft, 2008). ATV-related deaths and injuries are the most serious concern among stakeholders and users (Doud et al., 2017). In the US, 14 years and older youth can drive farm machinery as employees and many suffer from ATV injuries and fatalities (Hendricks et al., 2006; Topping, 2019). As early as 2003, 273 ATV deaths and over 68,000 injuries were reported in the US (Moroney et al., 2003). From 2007 to 2011, there were a total of 1,702 ATV-related fatalities reported in the US (Williams et al., 2014). Krauss et al. (2010) reported that serious injuries cost over $6.5 million in healthcare, indicating the economic burden associated with ATV uses. These negative impacts can reduce the net benefit that users receive from ATV recreation.

In this review, there is a comprehensive examination of economic studies evaluating the impact of ATVs on local economies. To understand the concepts discussed, the terms are defined as follows: economic activity refers to the flow of money through buying or selling goods or services within a county or state; economic contribution is defined as the gross change in economic activity; and economic impact refers to the net change in economy due to visitors spending on an event or attraction. The economic impact of ATVs in a community occurs when there is an inflow of outside money into the community from non-resident spending through ATV-related visits or activities. Non-resident expenditures are crucial in the economic impact assessment because ATV expenditures from residents do not contribute to the change of the economy, and such expenditures signify an economic activity rather than an

economic impact (Janke and Trechter, 2016). An economic impact assessment aims to assess the impact of such outside money inflow on the local economy, mainly in terms of ATV sales, wages, and jobs that occurred in local businesses due to new ATV-related money. The local economy refers to a financial system that includes varying sectors and businesses existing in a community to generate money, jobs, opportunities, and services for the local community.

Once the outside money is injected into the local economy, it circulates in multiple forms or transactions within the local businesses. This creates the economic multiplier effect, which is the sum of three components: direct effects, indirect effects, and induced effects. Direct effects are the initial expenditures from ATV riders in the local businesses. The benefit from the direct effect encourages local businesses to spend more at other businesses, resulting in indirect effects. The income generated by both direct and indirect effects then re-circulates within an economy, leading to the induced effects. The total economic impact of ATV riding on the community is the sum of all these three effects. Input-output models can be used to analyze the relationship between different interdependent sectors of the economy and quantify the overall economic impact of ATV tourism (Leontief, 1996).

The use of ATVs can have a positive impact on local communities by generating income via tourism-related expenditures (Okrant and Goss, 2004; Schneider and Schoenecker, 2006; Thomas et al., 2008; Southwick Associates, 2018). Several studies have also reported negative impacts of ATV usage on the environment, society, and human health (Chin et al., 2004; Foltz, 2006; Hunkapiller et al., 2009; Helmkamp et al., 2012; William et al., 2014; Vanlaar et al., 2015). These studies only discussed the negative impacts in narrative form but didn't evaluate the actual cost of those impacts in monetary terms. Costs of ATV damages to the environment, society, and human health are nonmarket in nature and are difficult to quantify in an existing market system. As such, these costs are often overlooked in economic impact studies that focus more on direct and indirect benefits revealed in the market. In recent decades, researchers have frequently utilized nonmarket valuation methods, including the contingent valuation method, choice experiment, and hedonic pricing to estimate the monetary value that individuals place on goods or services not traded in markets (Costanze et al., 1997; Champ et al., 2003; Bilberman and Andereck 2006; Regmi et al., 2023). It is important to consider both the benefits and costs associated with ATV use to have a complete understanding of the impact of ATV recreation. This can be useful to better manage and regulate ATV recreation while embracing sustainability goals for outdoor environments.

Several previous reviews have extensively explored safety concerns including injury, fatalities, and risks associated with ATV use in agriculture or recreation (Pelletier et al., 2012; Fawcett et al., 2016; Neves et al., 2018; Rattan et al., 2018; Khorsandi et al., 2023). A comprehensive review focusing on the economic impact of ATV uses on the local economy remains absent. This review aims to fill this gap by examining existing studies that specifically focus on the economic impact of ATVs, compare their similarities and differences, and examine whether they have included the costs of ATV damages to the environment, society, and human health in their economic assessment. By compiling and synthesizing available economic impact research on ATVs, this paper seeks to provide valuable insights for ATV business managers, policymakers, and researchers.

2. Methods

We conducted an extensive literature search using various academic databases, including Google Scholar and Web of Science CAB direct. The search utilized relevant keywords and their combinations: 'all-terrain vehicle/s,' 'quad bike/s,' 'off road vehicle/s,' 'off highway vehicle/s,' 'economic impact,' 'economic contribution,' 'motorized recreation,' and 'outdoor recreation'. While we found numerous studies related to ATV subjects, the primary focus was on investigations related to injuries and fatalities associated with ATV usage (e.g., Helmkamp et al., 2009; Shults et al., 2013; Lagerstrom et al., 2016; Doud et al., 2017). Our review did not identify any peer-reviewed journal articles exclusively focused on examining the economic impact of ATVs. Consequently, we expanded the search

criteria to include a range of supplementary sources like published reports, working papers, and proceeding papers, accessing studies from university researchers, various ATV industries, and user advocates through the National Off-Highway Vehicle Conservation Council (NOHVCC) website (https://nohvcc.org/economic-impact-studies/).

Our initial screening process identified 60 studies aligned with the designated keywords. We meticulously evaluated titles and abstracts for all 60 studies. Within this set, nine (9) studies explicitly mentioned the economic impact of ATVs in their title or abstract sections. A thorough full-body review of these nine studies revealed that four (4) provided a narrative discussion but lacked a comprehensive monetary assessment, leading to their exclusion. The remaining 51 studies, not explicitly highlighting the economic impact of ATVs, primarily focused on the economic impact of OHVs, outdoor recreation, and recreational areas. We classified these studies into two groups: 1) studies quantifying the economic impact specific to each OHV type; and 2) studies computing the cumulative economic impact of various OHV types. Two (2) studies aligned with the first criterion were deemed suitable for final analysis, while the 49 studies meeting the second criterion were excluded due to the inherent complexity in discerning the exclusive economic impact of ATVs within a combined assessment. Ultimately, we identified seven (7) publications from the United States, comprising reports spanning 2004 to 2022. A detailed synthesis of these studies is presented in Table 1 and expounded upon comprehensively in the subsequent sections of this research.

3. Results

3.1. Similarities and differences among the economic impact of ATVs studies

Summarized findings of the seven reports reviewed in this study are presented in Table 1. The table concisely presents the study objectives, the type of ATV users considered (i.e., resident, non-resident, or both), the approaches employed for economic impact analysis and the key results. Subsequently, we discuss the similarities and differences associated with each of these topics below.

3.2. Targeted groups for impact assessment (resident vs. non-resident)

Some studies did not explicitly mention whether they included residents or non-residents in the analysis, leading to the assumption that both were included. For example, Skelly and Loy (2016) conducted an onsite survey of ATV riders in Clinton County, Pennsylvania, in 2015, to understand the present and future potential economic impact of ATVs. They reported that ATV riders visit Clinton County an average of seven times a year and stay for about two days per trip, with an estimated annual expenditure of $1,400. Respondents indicated that connecting ATV trails between the local community and existing trails in the future would increase their visits to twelve times per year, potentially raising annual ATV expenditures to approximately $2,500 per rider. Another study by Imerman (2019) surveyed 1,500 registered OHV owners in Iowa in 2018 and evaluated the economic impact of each OHV type, categorized as ATV, off-road motorcycles, and side-by-sides. The result identified that out of a total of $96.4 million in expenditures generated by registered OHVs in Iowa, $19.9 million was contributed by ATVs. Similarly, out of the $147 million in-state expenditure generated by both registered and titled OHVs in Iowa, $44.1 million was contributed by ATVs.

Several other ATV economic impact studies differentiated between resident (local users) and non-resident ATV spending (i.e., new money brought to the region by visitors). In 2005, Schneider and Schoenecker (2006) collected data from a survey of Minnesota residents with registered ATVs and used secondary data to evaluate the economic impact of ATVs on those residents. The study did not include non-residents due to a lack of up-to-date information on non-resident ATV expenditures. This study reported an economic impact of $491.2 million from resident

expenditures and 8,756 jobs created. In contrast, in June 2005, another study by Camoin Associates (2006) evaluated ATV spending for both residents and non-residents in the Tug Hill region in New York, US. However, they only used non-resident expenditures in the economic impact assessment because resident spending is considered to represent economic activities that would have happened anyway and does not contribute to a change in the economy (Janke and Trechter, 2016). In the Tug Hill region, non-resident ATV spending had an estimated total economic impact of approximately $35.2 million and supported 701 employments.

Table 1. Descriptive information of studies that assessed the economic impact of ATVs in terms of gross expenditures (economic values are in US$).

Authors	Research Objective(s)	Resident/non-resident	Economic impact approach	Key findings
Schneider and Schoenecker (2006)	Assess the consumer profile and economic activity and impact of ATVs in Minnesota, US.	Resident	REMI (Regional Economic Models, Inc)	- Resident expenditures $491.2 mil. and 8,756 jobs. - Retail activity $79.3 mil. and 1,477 jobs - Manufacturing activity US $349.2 mil. and 4,216 jobs
Camoin Associates (2006)	Determine the economic and fiscal impact of ATVs in the Tug Hill region of New York, US.	Non-resident	IMPLAN (Impact Analysis for Planning)	- Non-resident expenditure ~$35 mil. and 701 jobs. - Discussed environmental and social costs and benefits of ATVs
Skelly and Loy (2016)	Determine the present and future economic impact of ATV recreation in Clinton County, Pennsylvania, US.	Undefined	Simple statistical measures such as average	- ATV riders' expenditures: $1,400/yr. - Trails if connected in the future, annual expenditure is expected to be ~$2,500 per rider.
Imerman (2019)	Estimate the expenditures, activities, and economic impacts of off-highway vehicle ownership and operation in Iowa, US.	Undefined	IMPLAN	- Registered ATV vehicles expenditure: min. US $19.9 mil. out of a total of $96.4 mil. - Registered and titled ATV expenditure: max. $44.1 mil. out of a total of $147 mil.
Rubin and Morrris (2005)	Assess the economic impact of ATVs and establish a dollar value for mitigating damage caused by ATVs in Maine, US.	Resident and Non-resident	IMPLAN Pro input-output model	- Resident ATV expenditures of $188 mil. and 1,852 jobs - Non-resident ATV expenditures of $12 mil. and 123 jobs - The cost of ATV damage ranged from $200k to several hundred thousand dollars per year.
Venegas (2009)	Create a profile of the Minnesota Recreational Trail Users Association, their expenditures, and economic impact on local economies in Minnesota, US.	Resident and Non-resident	IMPLAN	- Economic impact $228.1 mil. and 2,242 jobs
Okrant and Goss (2004)	Determine the impact of ATV/ Trailbike travel parties' state's economy in New Hampshire, US.	Resident and Non-resident	Undefined	- About 82% of ATV spending by residents and 18% by non-residents

The other three studies incorporated both resident and non-resident ATV spending in their economic impact assessment. In 2004, Rubin and Morrris (2005) surveyed resident and non-resident ATV-registered households in

the state of Maine. They found that resident spending contributed $188 million and generated 1,852 jobs, while non-resident spending contributed $12 million and added 123 jobs. This created a total economic activity of $200 million and supported 1,975 jobs in the state economy. However, considering the basic premise of economic impact assessment (i.e., resident spending does not contribute to economic impact), the actual economic impact in Maine would be only $12 million and 123 jobs, contributed by non-resident spending alone. Similarly, in 2008, Venegas (2009) estimated a total economic impact of $228.1 million on the local economy of Minnesota contributed by both resident and non-resident ATV-registered households, along with 2,242 jobs. Furthermore, Okrant and Goss (2004) evaluated the economic impact of resident and non-resident ATV users and travel parties on New Hampshire's economy from July 2002 to June 2003. They found that a higher proportion (82%) of ATV spending was solely contributed by resident ATV riders when compared to non-residents (18%). The authors concluded that the overall economic impact of New Hampshire could be increased by attracting more non-resident ATV riders, as their growth would raise the number of overnight trips, contributing to the ATV expenditures and revenue for the state.

3.3. Type of ATV expenditures

The reviewed studies showed inconsistency in differentiating between expenditures carried out in the local community versus the destination area. Local expenditures refer to money spent by ATV users within the local community, while destination expenditures refer to money spent at a location outside their home community. When ATV trips are taken within the home county, expenditures are limited to that county. In contrast, when trips extend outside the home county, expenditures occur in both the home and destination counties. The destination region is likely to experience a more significant economic impact from ATV users compared to the home county. For example, Rubin and Morrris (2005) instructed resident and non-resident ATV households to report only expenditures carried out in Maine and by members of their own households to evaluate the economic contribution of ATV-related activity in Maine. Venegas (2009) limited the collection of non-resident expenditures to the destination region, while resident expenditures included spending that occurred in both home and destination regions. Schneider and Schoenecker (2006) evaluated expenditures and economic impact for all ATV rides of Minnesotan residents that occurred in the home, in-route, and destination counties. The review suggests that the inclusion of both resident and non-resident expenditures in ATV economic impact assessment depends on the scope and objective of the study, regardless of the concept of economic impact.

ATV expenditures can be broadly classified into three broad categories: rider-related expenditures, trip-related expenditures, and ATV-related expenditures. Rider-related expenditures include clothing, helmets, goggles, two-way radios, and other accessories used by the riders. Trip-related expenditures include food and drink consumed on ATV trips, overnight accommodations, gas for tow vehicles, shopping (souvenirs, gifts), guided tours, and area entertainment as well as club memberships. ATV-related expenditures include gasoline and oil, ATV servicing, maintenance, repairs, registrations, storage and insurance, and the purchase of ATVs, trailers, and tow vehicles. We found that the types of expenditures used for the economic impact assessment varied across studies. Some studies clearly differentiated between these categories (e.g., Rubin and Morrris, 2005; Imerman, 2019), while others did not provide such distinctions (e.g., Camoin Associates, 2006; Schneider and Schoenecker, 2006; Venegas, 2009). For example, Skelly and Loy (2016) estimated overall expenditures by only collecting expenses on lodging, food, fuel, and the number of times the rider visited the destination.

3.4. Approach used for the impact assessment

The approach employed for the economic impact assessment of ATV riding varied among the studies. Most studies assessed the total economic impact of ATVs based on information collected on ATV expenditures and their

multiplier effects. The information on ATV expenditures was collected using survey methods and secondary, with various economic simulation programs used to calculate the multiplier effect of ATV spending. For example, the Impact Analysis for Planning (IMPLAN) tool was utilized in some studies (Rubin and Morrris, 2005; Camoin associates, 2006; Imerman, 2019), while other employed IMPLAN Pro© (Venegas, 2009), and Regional Economic Models, Inc (REMI) tool (Schneider and Schoenecker, 2006). In contrast, Okrant and Goss (2004) did not specify the economic impact tool used in the study but evaluated direct, indirect, and induced impacts along with multiplier effects. Skelly and Loy (2016) used a simple statistical method to estimate economic impact but did not calculate direct, indirect, and induced impacts on the local economy. Since the total economic impact of ATV riding is the sum of these three impacts, the absence of these impacts in the analysis may raise questions about the credibility of the findings.

3.5. Environmental, Societal, and Health Costs Associated with ATV Use

A review of seven economic impact assessment studies on ATV riding revealed that only two studies addressed the potential environmental, societal, and health impacts associated with ATV damage. Rubin and Morris (2005) did not include costs associated with ATV damages in their impact analysis, but calculated the annual monetary value of ATV damages to the environment to establish a damage mitigation fund for landowner reimbursement. They collected information on ATV damages and repair costs from landowner records, facing challenges in verifying whether the damage was caused by ATVs rather than other vehicles due to a lack of evidence. This limitation led to a scarcity of documented cases of ATV damage, repair information, and verified costs from the Department of Conservation.

Rubin and Morrris (2005) highlighted that the annual cost of ATV damage and related repairs ranged from $1,000 to $25,000 per mile, and $500 to $14,000 per site, depending on the extent of damage. They also pointed out that the Central Maine Power Company and Portland Natural Gas Company spent approximately $50,000 over two (2) years and $200,000 over three (3) years to repair ATV damages. The estimated annual cost for maintaining a robust ATV damage mitigation fund in the state of Maine ranged from two hundred thousand to several hundred thousand dollars.

Camoin Associates (2006) referenced past studies to provide narrative evidence of environmental costs associated with ATV use. For example, they cited US Forest Service data estimating environmental costs of around $1 million to revegetate 550 miles of illegal trails damaged by ATV use in the Chattahoochee-Oconee National Forests in Georgia. Based on the data from Tug Hill ski clubs and the Department of Environmental Conservation, they reported a cost estimation of $40,000 in materials and labor to repair 10 miles of trails damaged by ATVs in the Carpenter Road Ski Trail system in New York. These sources indicate the efforts to estimate the monetary costs of ATV damages to the environment.

Camoin Associates (2006) also provided descriptive insights into societal and health impacts linked to ATV usage in the Tug Hill Region of the US. Societal impacts included (a) noise pollution affecting nearby landowners and other trail users such as bird watchers, hikers, hunters, bikers, and wildlife, (b) crowding effect leading to a decrease in the number of other trail users, (c) illegal trespassing, (d) the spread of non-native plant species through ATVs tires, (e) crop and property damage, and (f) landowner liability. Health risks associated with ATV riding were discussed in the context of safety issues, emphasizing the rising number of injuries and fatalities caused by ATV use with common contributing factors (e.g., speeding, lack of experience, lack of safety gear, and alcohol use) identified in a report by the Canadian Institute for Health Information (2003). The authors pointed out that the costs of these injuries and fatalities are often borne by communities in the form of law enforcement and hospital care. The study highlighted a lack of attention to ATV safety at the national and state levels.

Camoin Associates (2006) noted varying and inconsistent regulations for children under 16 in different states,

indicating a lack of federal action to reduce the health costs associated with ATV riding. They presented a proposed policy in Nova Scotia, Canada, as an example policy measure to address safety concerns related to ATV use. This policy would require all ATV riders to wear a helmet, establish speed limits on ATV trails, and provide education and training for ATV riders on how to operate ATVs safely. The study also cited the Paiute ATV Trail located in central Utah, US, as an example of a safe trail designed for family sightseeing. The authors emphasized that implementing rider safety policies and formulating ATV rider education programs could potentially reduce the likelihood of injuries and fatalities in the future, alleviating some of the burdens on communities. Pelletier et al. (2012) mentioned that the lack of mandatory legislation is a key barrier to the promotion of ATV safety.

4. Conclusions

This review assessed potential similarities and differences among existing economic impact studies, specifically examining whether they included the costs of ATV damage to the environment, society, and human health in their economic impact assessments. We found variability among studies in terms of how they differentiated between spending by resident and non-resident users, the types of ATV expenditures considered, and the approaches used for economic impact assessment. Only a minority of studies solely based their assessments on non-resident expenditures, with others including resident ATV spending or combining both resident and non-resident spending. The identified variations in types of expenditures and study scope, spanning local, regional, and national levels, were found to affect the outcomes of economic impact studies, emphasizing the need for careful consideration by researchers to ensure accurate and relevant results.

In relation to the costs of ATV damages to the environment, society, and human health, the review indicates a predominant focus on the economic benefits derived from ATV expenditures. This indicates a lack of comprehensive inclusion of both benefits and costs. To address this discrepancy, future research should aim to adopt a holistic approach that considers the full spectrum of costs and benefits associated with ATV recreation in economic impact assessment. Review highlights the need for evaluating the economic impact of each OHV type individually because understanding the popularity and economic influence of each type is essential for promoting the most impactful OHV in the local economy.

The findings of this study can provide benefits to various stakeholders, including local communities, ATV business managers, policymakers, and researchers. Local communities can use these research findings to monitor the impacts of ATV business on their local economy and interdependent sectors, such as employment and household income, and make informed decisions about the future of ATV use in their region. ATV business managers in the tourism and recreation sector can leverage the research findings to make informed decisions about investments that significantly impact the local economy. The information can guide decisions on trial constructions, business marketing strategies, and the pricing of products and services. Policymakers can derive insights from this study to formulate strategies and plans for conducting more comprehensive economic impact assessments. This knowledge can be particularly relevant when making decisions related to land use and transportation planning, considering the economic impact of ATV riding. Researchers, with an understanding of existing gaps and inconsistencies in economic impact studies of ATV recreation, can conduct more reliable studies that align with the concept of economic impact.

Funding Statement

This research received no external funding.

Acknowledgments

Acknowledgments to anonymous referees' comments and editor's effort.

Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

Conceptualization: Kripa Neupane, Micheal Jacobson; Investigation: Kripa Neupane, Arun Regmi, and Micheal Jacobson; Methodology and Formal analysis: Kripa Neupane, Arun Regmi, and Lisa Grab; Writing – original draft: Kripa Neupane, Arun Regmi, Lisa Grab; Writing – review & editing: Kripa Neupane, Arun Regmi, Lisa Grab, Micheal Jacobson, and Timothy Kelsey.

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