

Dirty money as a carrier of corona virus and other pathogens: a survey article

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Received: 12 May, 2020

Accepted: 29 July, 2020

ABSTRACT

Money makes the world go round and corona virus could go round with it. Money in the form of paper currency or coins might be considered as the most dreadful carrier of different viruses or infections as it is one of the most often used items passing from hand to hand. Can dirty money spread the virus? Cash handling is a concern. Covid-19 which is the latest series in the corona virus family survives on surfaces for several hours or days and when we mean surfaces; it can be paper surface too. According to the World Health Organization, the use of dirty banknotes could pass around the corona virus or Covid-19 from one person to another. This paper draws attention to the studies conducted by researchers both at the national and international level on the impact of dirty money on human health. The present study also gives an insight into the theory of heterotopia where money occupy a public space and travels from one space to another as a potential carrier of pathogens. It also provides an interesting channel from various research studies to create awareness on growing health risks that may arise due to the use of currency and also suggest measures to overcome the same.

Key words: coins, paper money, formites, COVID-19, transmissible disease

Different people may interpret the term "dirty money" in different ways. However, according to microbiology, dirty money can be a transmitter of pathogens that can cause various diseases in humans. With the outbreak and spread of COVID-19, institutions around the world are contemplating the use of currencies as a harbinger of bacteria, viruses, or microorganisms that are harmful to human health. Cash, notes or coins, is perceived as a least hygienic everyday item. People who handle money regularly from business registers can expose themselves to a myriad of germs and there is a high possibility of spreading pathogens that are harmful to the human body. Pathogens are bacteria, viruses, or

microorganisms that can cause disease. Some of the bacteria like salmonella, staphylococcus, and streptococcus are commonly found on money and credit cards as evident from various studies that can cause serious illness to individuals handling cash. With COVID-19 (Corona Virus Disease-19) as the pandemic continues to evolve real-time training during global emergencies is critical for effective preparedness and response. As money is a potential carrier of pathogens, it cannot be ignored how we "handle" it. Pandemic preparedness calls for urgent and aggressive actions to combat disease like COVID-19.

Throughout history, as human spread across the world diseases have universally threatened the survival of human beings (Ackerman, Hill, & Murray, 2018; Schaller & Park, 2011). Infectious diseases have been a constant companion. Even

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in this modern era, outbreaks are nearly constant. Smallpox came to North America in the 1600s. The USA in the period between 1832 and 1866 had a dangerous three waves of cholera which is an infection of the intestine while New York faced "Spanish Flu" in 1918. In fact, the world had to face several other pandemics like Bubonic Plague, Polio, Measles, to name a few.

In response to such threats, humans engaged in behavioural responses to avoid contact with pathogens to ensure survival such as lowering their sociability and movement at the interpersonal level (Mortensen, Becker, Ackerman, Neuberg, & Kendrick, 2010). But how to distance ourselves from dirty money which is colonised with various pathogens remains a debatable question.

Foucault (1986) introduced the concept of heterotopia which has been explored to understand the aspects of money as a public space. Foucault describes heterotopias as a heterogeneous space where certain institutional and cultural spaces are by some means disturbing and incompatible because it creates a world inside a world. Money form heterotopias, when their utopic purity orbits around the public space which is juxtaposed with the private spaces.

Currency passes from one space to another which becomes a potential site for contagion. Heterotopias of crisis are created which are spaces that can accommodate often violently contradictory differences like prisons and luxury hotels simultaneously. Money travels from one space to another from cardboard boxes of homeless to the people residing in skyscrapers. If a new form of money is designed, a new form of

society will rise from this design which would probably change the premises on which all economic activities takes place in a capitalist system. Money occupies such a space where it transcends all boundaries. It goes round and with it the virus travels all spaces, around the most elitist to someone who has nothing. In "The Poetics of Space" Bachelard (1964) introduces his concept of topo - analysis as the systematic psychological study of the spaces of our intimate lives. The house, he says is the most intimate of all spaces, and now with post- Covid, dirty currency will occupy a space in our house intimate yet distant.

Bachelard underlines the ways in which ambiguous spaces in our world require perceptual alertness and acute flexibility. According to him society has turned a blind eye to the dystopia. The journey into intimacy is skilfully evoked in 'The Poetic of Spaces' by drawers, cupboards, wardrobes and above all locks. He warns, as it should not be used as gratuitous metaphors. Money as a space has twofold significance involving internal diversity versus external connectedness and a carrier of potential pathogens that can emerge as a pandemic like Covid-19.

METHODOLOGY

The study is based on secondary data and relevant information and data have been collected from various publications in journals, articles, newspapers, editorials, analytical pieces, media houses, etc., available online. Whatever relevant articles or studies were available in the electronic form were examined and put to review. The findings of the available studies are summarized and are presented in the following discussions.

LITERATURE REVIEW

A brief review of the related study involves opinions of different authors, scholars and economists, and also evaluates reports of research work related to actual research proposed to be undertaken. Dirty currencies can create health havoc on human lives. This study provides a solid ground for the necessity and desirability of undertaking an anatomy of the various studies conducted across the globe by researchers to create awareness and encourage further research on the ill effects of dirty money. A brief review of the related study involves opinions of different authors, scholars and economists, and also evaluates reports of research work related to actual research proposed to be undertaken. In this connection, the studies of some authors who have contributed to research in the field of the proposed problem are enumerated below.

Studies on Dirty Money in the International Level:

The analysis of dirty money remained a neglected discipline and was not recognized as a distinct field of research till the 1970's. However, after 1970, there has been a large volume of publications and several attempts have been made to investigate the microbial population in currency notes in various parts of the world. The earlier studies on dirty money dates back to 1972 carried out by Abrams and Waterman who considered the possibility of currency notes acting as environmental vehicles or fomites for the transmission of potential microorganism.⁶

In order to analyse the degree of faecal contamination of currency notes with enteric bacterial in a local market in Rangoon, samples of the notes that were in circulation were collected from butchers and fish mongers and examined bacteriologically to count the number of total bacteria and faecal coliforms (TC, FC) using standard methods and tools. Enteric pathogens,

such as *Enterotoxigenic Escherichia Coli*, *Vibrio*, and *Salmonella* were isolated from paper-money samples. The study reveals that isolation rates of pathogens increased during the hot wet season where the count of the number of total bacteria and faecal coliforms ranged from 0 to 2.9×10^7 /sq cm of currency notes. The study suggests that currency notes may carry enteric pathogens.

A probable cause for bacterial and parasitic transmission by paper currency in 4 major cities of Nigeria was conducted by collecting 250 currency notes obtained from butchers and beggars. The study concludes that 21.6% were contaminated with enteric parasites including *Ascaris lumbricoides*, *Enterobius vermicularis*, *Trichuris trichiura* and *Taenia* spp.

A study was conducted in Nepal concerning the possible transmission of bacteria through Nepalese currency, the Rupee. In order to examine the prevalence of contamination in Nepalese rupee, 28 samples of the same were collected consisting of notes in all seven denominations (Rupees 5, 10, 20, 50, 100, 500 and 1000). Coins were not tested as the rate of coin circulation in Nepal is declining. Bacteriological analysis was conducted on 24 currency notes. The results reveal 75% of various kinds of pathogenic bacteria. In fact this analysis established 84.8 % contamination in notes acquired from conductors of local minibuses, 78.0 % from butchers and 62.1 % from food sellers. The notes which were collected from banks and tested were free from bacterial contamination.

In order to investigate the hygiene status and bacterial content on banknotes, a total of 1280 banknotes were obtained from food outlets in 10 different countries namely the United States, Australia, United Kingdom, Ireland, Burkina Faso, New Zealand, China, the Netherlands, Nigeria and Mexico. After laboratory simulations, a strong correlation was found between the number of

bacteria per square centimetre and a series of indicators of the economic prosperity of the mentioned countries. The strongest correlation was found with the "index of economic freedom. The study concludes by indicating that bacterial content on the banknotes was higher when the index of economic freedom was low.

Another study was aimed at determining the prevalence and load of bacteria on Kenyan currency notes in circulation in the Nairobi CBD area which is the centre of the Kenyan economy. A total of 7 Banknotes were sampled randomly and isolated for bacteria using Nutrient agar, Eosin Methylene Blue agar and Mannitol Salt agar. The samples were collected from a Public service vehicle conductor of Route 23 (Nairobi - Kangemi), a Vegetable vendor from City Market, a butcher from City market, a teller from a supermarket and the Central Bank of Kenya. Both notes and coins were sampled. Various denominations of money were sampled; 100 shilling notes, 50 shilling notes, and 10 shilling coins. After appropriate media preparation, culturing, isolation, gram staining and microscopic observation, various genera of bacteria were isolated. They included the predominant *Staphylococcus* sp., *Bacillus* sp.,

Escherichia coli and possibly *Salmonella* or *Shigella* sp. *Staphylococcus aureus* and *Staphylococcus epidermidis* were also isolated. It was therefore concluded that Kenyan banknotes on circulation could act as a route for the transmission of potential pathogenic microorganisms that could lead to the manifestation of serious diseases. It is therefore important to maintain proper hygiene to reduce these high risks of infection.

In order to establish the survival status of bacteria including *Staphylococcus aureus*, *E. coli*, and *Vancomycin-Resistant Enterococci* (VRE) on banknotes from countries around the world and deliberate how money can transmit bacteria to

volunteers getting in contact with contaminated banknotes, a study was conducted in the Netherlands. For this experiment, various currencies across the globe like Euro, US Dollar, Canadian Dollar, Croatian Lira, Romanian Leu (RON), Moroccan Dirham, and Indian Rupee banknotes were included and all of them yielded microorganisms.

Parasitological analysis of the Pakistani currency reveals 92.5% of Pakistani currency to be contaminated with pathological microorganisms. A parasitological, fungal, aerobic and anaerobic microbial analysis was conducted by using various microbiological techniques. For this, a total of 81 Pakistani currency notes and coins in circulation were randomly collected from different shopkeepers, vendors, canteen owners and restaurant cashiers in Lahore. The results reveal that Pakistani currency is contaminated with pathological microorganisms namely *staphylococcus* spp., *Micrococcus* spp., *bacillus cepacia*, *klebsiella pneumoniae*, *serretia rubideae*, *Bacteriodes* spp. and yeast and mold.

A cross-sectional study was conducted in Saudi Arab to assess the presence of microbial pathogens of paper currency collected from ten selected public places of Al-Kharj. The results from the study suggest that the higher microbial contaminations were found in lower currency denominations. The most significant source of contaminated currencies came from small eating outlets. The various microorganisms present in the currency notes were *Bacillus* spp. (56.84%), *Staphylococcus* spp. (25.03%), *Klebsiella* spp. (13.40%) and *E. Coli* (04.71%).

In order to determine bacterial contamination of paper currencies in Iran, 337 currency notes of different value were collected from markets, shops, restaurants, bus stations and banks in Kashan, Iran during April 2015 to March 2016. By using standard microbiological methods, antibiotic resistance patterns of isolated bacteria

were determined by the disk diffusion method. Out of 337 currency notes, 262 (77.7%) were identified with bacterial contamination like *Bacillus* spp., *coagulase-negative staphylococci*, *Escherichia coli* 20 (7.6%), *enterococci* species, *Staphylococcus aureus*, *Klebsiella* spp., *shigella* species, and *Pseudomonas* species. The most and least contaminated currency notes were 50000 and 500 Rials, respectively.

A similar research was conducted in Pakistan from 4/3/2010 to 31/1/2011. Around 720 samples of currency of different denominations were collected from various sources - 243 sample were collected from bank, 50 samples from ATM Machine 80 samples from meat shops, 92 samples from milk seller, 35 samples from medical store, 94 samples from food seller, 63 samples from grocery shop, 36 samples from road side mechanics, 4 samples from bus conductor and 23 sample from beggars. Standard methods were used to process all the samples. 100%, microorganisms were found from denominations collected from bus conductors, 82.6% from beggars and 28% found from the bank counter. The presence of microorganisms is lowest in denominations collected from bank counter might be because of the supply of the cleaner currency notes in comparison with currencies collected from other sources

Another study concentrated on the hygienic and microbial status of Sudanese banknotes, Khartoum State, Sudan. Fifty samples of Sudanese banknotes were collected randomly from handlers through (March - April / 2015). These samples were microbiologically tested for quantify bacteria, identification of bacteria and fungi (Yeasts and Moulds) by using biochemical tests for bacteria and phenotypical characteristics for fungi.

The study showed that the mean of total viable count (CFU/cm²) of bacteria contaminated of

banknotes between $(4.5 - 8.3) \times 10^5$ CFU/cm² the study indicated 12 different types of bacteria and 5 types of fungi was identified from banknotes with different percentages. Of 50 questionnaires that were statistically analysed; 76% of handlers knew contaminated banknotes as being a source of infection; 94% educated handlers at different levels; 64% of the handlers washed hands after using toilets and before dealing with banknotes again.

A pilot study was conducted in New York City to study the presence of microbes found on circulating currency. The researchers obtained \$1 bills from a New York City bank in February (winter) and June (summer) 2013. They used basic culture conditions and shotgun metagenomic sequencing to test viable microbes on their surface. The results confirmed high levels of human eukaryotic DNA with high incidences of *E. caballus* (horse), *S. scrofa* (wild boar), and *C. lupis* (grey wolf) on currency, however the same was found particularly less in the summer bills.

Research in Rwanda Frank attempted to analyse the bacterial, fungal and protozoan contamination and source of infection in currency notes and coins. For this experimental purpose a microbiological analysis was done by randomly collecting 108 paper currency notes of Rwanda Frank and 55 of coins were from vegetable sellers in market places in Musanze district (Rwanda) during November 2017. The results of the study indicate the presence of a huge number of pathogens. Out of 108 paper currency notes, 23% of *E. Coli* was reset in 25 notes, 36% of *Staphylococcus aureus* in 40 notes, 18% *Klebsiella pneumonia*, and *Pseudomonas* in 20 notes, 29.5% *Clostridium* spp in 32 notes, 41% of *Streptococcus pyogenes* in 45 notes, 21% *Bacillus subtilis*, *Vibrio* spp in 22 notes, 35% *penicillium* spp in 38 notes, 18% *Aspergillus* spp in 20 notes, 16% *Rhizopus*, *Candida* and *Alternaria* in 18 notes, 27% *Entamoeba histolytica* in 29 notes, et, to name just a few.

Studies on Dirty Money in the National Level

At the national level, a study of its kind was carried out in Bhopal in the mid-90s to study the microbial contamination of Indian currency. 180 Indian currency notes including each of Rs. 5, Rs. 10, Rs. 20, Rs. 50, Rs. 100 and Rs. 500 denominations, were collected from peoples of various social strata. The study concluded that among the total 180 Indian currency notes 169 (93.89%) were contaminated, both with pathogenic and non-pathogenic organisms that risk and generate public health hazards to the individuals and community as a whole.

A research was carried out in the North East part of India, Assam to test whether paper currencies act as a potential carrier of pathogenic microorganisms. To conduct the microbial analysis, dirty paper currencies comprising 500 rupee, 100 rupee, 50 rupee, 20 rupee, 10 rupee, 5 rupee were collected from the butchers, sweepers & fish mongers. The results of the study show the presence of pathogenic bacteria namely *Pseudomonas* spp., *E. coli*, *Klebsiella* spp., *Staphylococcus* spp., and *Streptococcus* spp. The study concludes by stating that the deposition of the moisture on the paper currencies provided favourable conditions for the microorganisms to grow on it.

A research using metagenomics and high-throughput DNA sequencing technique was carried out in New Delhi to examine the presence of microbes in currency notes. They collected notes from random spots such as street vendors, grocery shops, snack bars, canteen, tea shops, hardware shops and chemists across New Delhi. Investigation of the data revealed the presence of species 78 pathogens including *Staphylococcus aureus*, *Corynebacterium glutamicum*, *Enterococcus faecalis*, and 75 cellulose degrading organisms including *Acidothermus cellulolyticus*, *Cellulomonas flavigena* and *Ruminococcus albus* belonging to both

eukaryotic and prokaryotic genera. In addition, 78 antibiotic resistance genes were identified and 18 of these were found in all the samples. Furthermore, six out of 78 pathogens harboured at least one of the 18 common antibiotic resistance genes.

A study was undertaken in Lucknow city to confirm microbial contamination of currency and also introduce the nature and levels of contamination of the Indian currency. To conduct the study, total 96 paper currency and 48 coins of different denominations were randomly collected from vegetables seller, chemist store, butcher shop, auto rickshaw and rickshaw man, tuberculosis chest outpatient department (OPD) and general OPD from the different areas of Lucknow city in a sterile paper bags. The results suggest the presence of contaminated microbes like bacterial and fungal isolates which play a vital role in transmitting antibiotic resistant or potentially harmful organisms.

A prospective study was carried out in a tertiary care hospital in Tirunelveli City, Tamil Nadu, India to assess the microbial contamination of paper currency notes. The investigation was carried out by collecting 121 Indian paper currency yielding 6 different types of bacterial species. Assessment of the study revealed the presence of pathogenic micro-organisms like *Escherichia coli*, *Bacillus* spp, *Klebsiella* spp, *Staphylococcus aureus*, *Micrococci* and *Pseudomonas* spp. The study also revealed that lower denominations like Rs. 5, Rs.10, Rs.20 were moderately contaminated, higher denominations like Rs.500 and Rs.100 were less contaminated and Rs.100, Rs.50 notes were more contaminated.

An online questionnaire-based study was conducted through a survey planet link to conform that money acts as a vector for transmissible diseases. The respondents who undertook the survey are undergraduate students of various medical and dental colleges,

school students, and other professionals in the working industry. The 22 questions were based on their awareness on the diseases that could be spread through currency and coins. The study concluded that currency in the form of cash and coins transmit diseases and suggest resorting to digital transactions and washing hands after handling currency.

RESULTS AND DISCUSSIONS

What is evident from the above studies is that microorganisms or pathogens might appear on currencies due to several reasons namely poor handling, moisture deposition due to application of saliva on fingers while counting money or through open wounds or scratches on the hands, etc. Further, contamination from nasal discharge, sneezing and coughing are major sources of transfer of bacteria or virus to currency notes during handling, etc. Currency notes are often kept warm by our body heat and even absorb our body moisture, helping bacteria to grow faster. To support the studies, an instance can be cited of 2016 demonetization in India when due to the surge in cash transactions, bankers were forced to do manual counting which led to a host of health hazards like allergies and breathing problems besides rashes on their fingers.

The Covid-19 pandemic has raised public apprehension that the corona virus could be transmitted by cash. In fact the research on novel COVID-19 concerning the transmission of the virus is gaining momentum. Research in microbiology proves the presence of pathogens on coins and banknotes. Some viruses can last for hours on banknotes when diluted with mucus while some bacteria and viruses can be readily transmitted through non porous surfaces. A recent study on corona virus reveals that Covid-19 can persist for three hours in the air, 24 hours on cardboard and even longer on other hard surfaces. In fact, according to a German disease expert as cited in Reuters 2020, the virus survives

best on non-porous materials, such as plastic or stainless steel indicating that debit or credit card terminals or PIN pads could transmit the virus too. To date, there are no known cases of Covid-19 transmission via banknotes or coins.

Even though there is no conclusive scientific evidence to stand as a testimony to the fact that corona virus can spread through contaminated currency notes, the World Health Organisation has recommended following adequate hygienic measures after handling hard cash.

CONCLUSION

It is certain that cash could spread pathogens, though it has not been proved so far whether it carries the corona virus or not. Hence, a realistic appraisal of the risks of transmission of corona virus through cash is particularly important. With the ongoing pandemic, the payment behaviour would change definitely. The apprehension of using cash comes as the global number of people infected by the corona virus numbers around 11,635,939 as on 8th July, 2020.

Although till date, there are no known cases of Covid-19 transmission via banknotes or coins, with the outbreak of COVID-19, many nations across the globe are undertaking suitable measures to sterilize currency in banks by using ultraviolet light, supersonic and chemicals means to trim down the risk of transmission of infection or virus through dirty money. Central Bank of South Korea resorted to extreme steps of taking all banknotes out of circulation for two weeks and even burning some for containing the virus. Initially since China was the epicentre of the virus and most of the cash got circulated from high risk infected areas and hospitals, it took enormous initiative of sanitizing and disinfecting potentially infected cash with ultraviolet light and high temperatures, and even to the extent of destroying cash. The Central bank of Kuwait, Hungary, South Korea and many other countries ensure that the cash were sterilize before leaving

the bank. While the Central bank of Georgia, Indonesia and India encouraged cashless payments.

The COVID-19 outbreak killing countless people across the globe has made people aware of the menace of handling and using currency notes. Hence replacing traditional methods of trading with electronic money transactions would of course be a good resolution for the problem. Contactless card payments like Google Pay, Samsung Pay, Paypal Apple Pay, Paytm, to name a few can act an effective tool to curtail physical contact and minimise physical contact. The pandemic which has created havoc worldwide might compel people to shun the use of cash and resort to digital payments like net banking, debit and credit card payments. Lockdown and social isolation which have compelled many businesses to shut down; cash is no longer a feasible mode of payment for many. However imagining a world not using cash at all sounds utopian particularly for a nation like India where people are yet not digitally educated enough for resorting to electronic mode of transactions. Being alert and alarmed with the prevailing situations, sanitizing hands and following hygienic practices after handling currency notes might prevent transmission of microbes or corona virus from spreading through dirty money.

REFERENCES

Ackerman, J.M., Hill, S.E. and Murray, D.R. 2018. The Behavioral Immune System: Current Concerns and Future Directions, *Social and Personality Psychology Compass*, **12** (2): 1-14. DOI: <https://doi.org/10.1111/spc3.12371>.

Chad, R., Mortensen, D., Vaughn Becker, Joshua M., Ackerman, Steven, L. Neuberg, Douglas T. and Kenrick. 2010. Infection breeds reticence: The effects of disease salience on self-perceptions of personality and behavioral avoidance tendencies. *Psychological Science*, **21**: 440-447.

Foucault M. 1986. Of Other Spaces: Trans. J. Miskowiec. Diacritics Spring. 22-27.

Magali Peyrefitte, Erin Sanders-McDonagh. 2018. Space, power and sexuality: transgressive and transformative possibilities at the interstices of spatial boundaries. *Gender, Place & Culture*, **25** (3): 325-333.

Bachelard, Gaston. The Poetic of Spaces. Boston: Beacon Press. 1994.

Abrams B.I. and Waterman N.G. Dirty Money. 1972 *JAMA*, **219**: 1202-3.

Khin Nwe O., Phyu Phyu Win, Aung Myo Han, Aye T. 1989. Contamination of Currency Notes with Enteric Bacterial Pathogens. *Journal of Diarrhoeal Diseases Research*, **7** (3 &4): 92-94.

Uneke C.J., and Ogbu, O. 2007. Potential for Parasite and Bacteria Transmission by Paper Currency in Nigeria. *J. Environ. Health*, **69** (9): 54-60.

Lamichhane, J., Adhikary, S., Gautam, P., Maharjan, R., & Dhakal, B. 2009. Risk of Handling Paper Currency in Circulation Chances of Potential Bacterial Transmittance. *Nepal Journal of Science and Technology*, **10** (1): 161-166.

Frank Vriesekoop, Cryn Russell, Beatriz Alvarez-Mayorga, Kofi Aidoo, Qipeng Yuan, Amalia Scannell, Rijkelt R Beumer, Xiuping Jiang, Nicolas Barro, Kome Otokunefor, Cheralée Smith-Arnold, Amy Heap, Jing Chen, Montserrat H Iturriaga, Wilma Hazelenger, Jenny DeSlandes, Brandon Kinley, Kieran Wilson, Garry Menz. 2010. Dirty money:

- An investigation into the hygiene status of some of the world's currencies as obtained from food outlets. *Foodborne pathogens and disease*, 7(12): 1497-502. Epub 2010 Aug 12. doi: 10.1089/fpd.2010.0606.
- Catherine Wambui Kamau. 2013. A project Report submitted for examination in fulfilment of the requirements for Course Unit SBT 414. (Research Project in the B. Sc Microbiology and Biotechnology degree programme, School Of Biological Sciences CBPS University Of Nairobi.).
- Gedik, H., Voss, T.A., and Voss. 2013. A Money and Transmission of Bacteria. *Antimicrobial Resistance and Infection Control*, 2(1): 2994-2-22. doi:10.1186/2047.
- Butt, A. and Malik S. 2015. Microbial and parasitic contamination on circulating Pakistani Currency. *Adv. Life Sci.* 2(4): 150-157. <http://www.als-journal.com/242-15/>
- Ahmed M.M., Fatima F, Ansari Mohammad, Al-Shdefat, Ramadan Anwer, Mohammad Jamil, Shahid Osman, Mutasim Saeed, Yonus Noor, Mohammed Katakam Prakash and Farheen Ayesha. 2017. Bacterial contamination of Saudi Arabian paper currency: A report from Al-Kharj. *Adv. Life Sci.*, 4(2): 27- 32. <http://www.als-journal.com/421-17/>
- Farzaneh Firoozeh, Ehsan Dadgostar, Hussein Akbari, Mohammad Zibaei, Seyed Mohammad Sadjjad Sadjjadian, Mohammad Mehdi Moshtaghi , Alireza Shakib. 2017. A Bacterial Contamination of Iranian Paper Currency and Their Antibiotic Resistance Patterns. *Int J Enteric Pathog*, 5(4): 106-110. doi: 10.15171/ijep.2017.25.
- Badvi J.A., Jawed K. and Jawed M. 2017. Lower Denomination and Dirty Currency Carries More Contaminated than Higher Denomination in Pakistan. *Int J Vaccines Vaccin*, 4 (3) 00082 . D O I : 10.15406/ijvv.2017.04.00082.
- Hassan M. and Honua M. 2017. The hygienic and microbial status of Sudanese banknotes, Khartoum State, Sudan. *Int. J. Community Med. Public Health*, 4: 923-7.
- Maritz J.M., Sullivan S.A., Prill R.J., Aksoy E., Scheid P., Carlton J.M. 2017. Filthy lucre: A Metagenomic Pilot Study of Microbes Found on Circulating Currency in New York City. *PLOS ONE*, 12 (4), e0175527.
- G. R., Neel, Marcelline U, Cedrick Izere, Karemera K John, Aimable, N, Innocent, H. 2018. Contamination of Currency notes and Coins as Sources of Transmissible Diseases. *International Journal of Pharma Research and Health Sciences*, 6 (1): 2334-37.
- Kalpna S., Mahobe, H, and Saxena G. 1995. Microbial Contamination of Indian Currency Notes in Bhopal. *Journal of Evolution of Medical and Dental*, 3 (6): 1379-1384.
- Borah D., Parida P. and Kumar T. 2012. Paper Currencies, A Potential Carrier Of Pathogenic Microorganisms. *International Journal of Applied Biology and Pharmaceutical Technology*, 3 (1): 23-25.
- Saakshi Jalali, Samantha Kohli, Chitra Latka, Sugandha Bhatia, Shamsudheen Karuthedath Vellarikal, Sridhar Sivasubbu , Vinod Scaria, Srinivasan Ramachandran. 2015. Screening Currency Notes for Microbial Pathogens and Antibiotic Resistance Genes Using a Shotgun Metagenomic Approach. *PLOS One*, 10 (6).
- Sunita Singh, Mastan Singh, Madhuban Tiwari, Santosh Kumar, Pratibha Kumari, Shivani Saxena. 2015. Indian currency uncovered with microbes retrieved from expected and unexpected transaction points Indian currency contamination. *International Journal of Medicine and Public Health*, 5 (3): 242 - 246.
- G. Sucilathangam, Ajay Mal Reventh, G. Velvizhi and C. Revathy. 2016. Assessment of Microbial Contamination of Paper Currency Notes in Circulation. *International Journal of Current Microbiology and Applied Sciences*, 5 (2): 735-741.
- V. P. R. B. Ranjith Raj, V. Vishnu Priya, R. Gayathri. 2018. Awareness on diseases spread through currency. *Drug Invention Today*, 10 (8): 1400 -1403.

- Reddy Siva Rami. 2016. Dirty notes give bank staffers 'cash allergy'. *Deccan Chronicle*. Nov 18. Angelakis, E., E.I. Azhar, F. Bibi, M. Yasir, A. Al-Ghamdi, A. Ashshi, A. Elshemi and D. Raoult. 2014. Paper money and coins as potential vectors of transmissible disease. *Future Microbiology*: 249–61.
- Thomas Y., G. Vogel, W. Wunderli, P. Suter, M. Witschi, D. Koch, C. Tapparel and L. Kaiser. 2008. Survival of influenza virus on banknotes. *Applied and Environmental Microbiology*: 3002–3007.
- Lopez, G., C. Gerba, A., Tamimi, M Kitajima, S. Maxwell and J. Rose. 2011. Transfer efficiency of bacteria and viruses from porous and nonporous fomites to fingers under different relative humidity conditions. *Applied Environmental Microbiology*, **79** (18): 5728–34.
- Van Doremalen, N. T. Bushmaker, D Morris, M. Holbrook, A. Gamble, B. Williamson, A. Tamin, J. Harcourt, N. Thornburg, S. Gerber, J. Lloyd-Smith, E de Wit and V. Munster. 2020. Aerosol and surface stability of SARSCoV-2 as compared with SARS-CoV-1. *NEJM.org*, March.
- Reuters. 2020. Banknotes carry no particular corona virus risk: German disease expert", 11 March.
- Centre for Disease Control. 2020. How to Protect Yourself? March. Dirty money: Can corona virus spread through bank notes? <https://scroll.in/article/957211/dirty-money-can-coronavirus-spread-through-bank-notes> Coins carry viruses better than paper money, experts say as China begins sterilizing cash. *Business Insider India*, accessed Mar 10, 2020.
- <https://www.businessinsider.in/science/news/coins-carry-viruses-better-than-paper-money-experts-say-as-china-begins-sterilizing-cash/articleshow/74567093.cms> Auer R, Cornelli G and Frost J. 2020. Covid-19, cash, and the future of payments. *Bank for International Settlements*, **3**: 1-7.
- Kelly Samantha Murphy. Dirty money: The Case Against Using Cash During the Corona virus Outbreak," *CNN Business News*, March 7, 2020.