



Research article

Antibiotic stewardship knowledge and belief differences among healthcare professionals in hospitals: A survey study

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ABSTRACT

Background: Collaborative practice in healthcare has been recommended to improve the quality of antimicrobial stewardship interventions, a behavioral change in antimicrobial use. Insufficient knowledge regarding antibiotic resistance, the fear of complications from infections, and how providers perceive antibiotic use and resistance are likely to influence prescribing behavior. This study's objective was to identify the knowledge and belief healthcare professionals' differences about antibiotic stewardship.

Methods: This cross-sectional survey study of three hospitals in the East Java province, Indonesia utilized a 43-item questionnaire to assess antimicrobial stewardship knowledge and belief. There were 12 knowledge questions (total possible score: 12) and 31 belief questions (total possible score: 155). The Kuder Richardson 20 (KR-20) and Cronbach alpha values of the questionnaire were 0.54 and 0.92, respectively.

Results: Out of the 257 respondents, 19% (48/257) had a low scores of knowledge, and 39% (101/257) had low scores on belief about antibiotic stewardship (101/257). Most midwives had a low scores on knowledge (25/61) and low scores on belief (46/61). Respondents with high scores on belief were 17% (10/59) physicians, 15% (4/27) pharmacists, 8% (5/65) nurses, and 3% (2/61) midwives.

Conclusion: Among healthcare professionals, knowledge and belief differences concerning antibiotic stewardship vary widely. These differences will affect their capability, behavior, and contribution to the healthcare team collaboration and performance. Further studies are needed to evaluate the correlation between the level of inter-professional collaboration and the quality of the antibiotic stewardship implementation.

1. Introduction

Collaborative practices in healthcare optimize antimicrobial use. Antimicrobial use in hospitals remains high [1,2]. A study conducted by the Vermont Oxford Network reported a 34% relative risk reduction of the median antibiotic use rate with an improved collaborative practice (leadership, accountability, drug expertise, actions, tracking, reporting, education) [3]. A decreasing the number of subtherapeutic first troughs (the risk of development of antimicrobial resistance) and increasing the number of therapeutic troughs (the increases of treatment effectiveness)

[4] was reported as a result of collaborative practice pharmacist and physician in determining the initial vancomycin dose for adult patients in the intensive care unit (ICU). Vancomycin typically takes 36–48 h to reach a steady state. It was reported that involving a pharmacist, being a medicine expert, in a physician's rounds in an intensive care unit reduced prescribing orders by 66% [5].

It is recommended that, to achieve the antimicrobial stewardship (AMS) goals effectively, an AMS team minimally includes contributions of either an infectious disease (ID) specialist physician, a microbiologist (if available) and a pharmacist. An ID physician supervises the overall

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function of the ASP and makes recommendations to the ASP team [6]. Pharmacists evaluate antibiotic consumption, participate in Drug and Therapeutics Committee [7] and AMS committee meetings [7,8]. Furthermore, the nurses' role as a patient caregiver [9], patient advocate [10], and the one who provides education to patient [11] is essential [12]. Along with physicians and pharmacists, nurses are the most consistent patient care givers in reviewing medication charts to administer medications, monitoring duration and indication for antimicrobial treatment, monitoring the possibility of drug allergies and side effects incidence, ensuring timely administration of antimicrobials, and following up on missed doses [9].

According to the World Health Organization (WHO): "Collaborative practice happens when multiple health workers from different professional backgrounds work together with patients, families, care givers and communities to deliver the highest quality of care. It allows health workers to engage any individual whose skills can help achieve local health goals." [13]. There are some theories that support the importance of collaborative practice in antibiotic stewardship. One is the behavior change advocated by Michie et. al (2011), which includes the COM-B model of behavior that identifies three factors for any behavior to occur: capability (C), opportunity (O), and motivation (M) [14]. The COM-B model can be applied to understand behavior and to effect behavioral changes in antibiotic use, whereas the Health Belief Model (HBM) theory explains and predicts person's behavior. Based on the HBM theory by Rosenstock, at an individual level, a person's actions are determined by their beliefs and cues to action [15]. Belief itself consists of perceived threats (possibility of facing the disease), perceived benefits (of understanding the benefits of adapting a new behavior), perceived self-efficacy (one's ability to successfully perform the recommended behavior), and perceived barriers (cost and obstacles which prevent us from doing a behavior) [16,17]. Our beliefs are affected by factors as age, gender, type of profession, length of work, and knowledge. Antibiotics stewardship programs are used worldwide to control antibiotic resistance through improving antibiotic use. One of the strategies of the antibiotic stewardship program is to increase the stakeholder's knowledge about antibiotic stewardship in using antibiotics judiciously. More than half of healthcare practitioners in Fitch town, Ethiopia, were found to have good knowledge (the respondents agree on >70% of the 5-Likert scale statement of practice) in terminology and effectiveness of antibiotic stewardship [18]. However, very few health practitioners (16%) adhered consistently to the management of the antibiotic stewardship program [18]. Moreover, a study at a Riyadh hospital in Saudi Arabia reported that among 212 physicians; 119 (56%) physicians believed that antibiotic resistance causes problems in the community and economic losses for the country; 101 (48%) physicians believed injudicious empiric antibiotics therapy was the main factor in the occurrence of antibiotic resistance; and 95 (45%) physicians were unsure about their knowledge about the appropriate use of antibiotics [19]. A qualitative study in Indonesia explored the education and awareness of healthcare professionals. The participants said that in the university, the lecturer should teach students more about the impact of antibiotic resistance; and the professional organization should provide education for practicing healthcare to keep them up to date with the latest developments [20]. Besides knowledge, the predictor of an effective team performance was trust level, years of previous experience, and the number of team members [21]. The objective of this study was to identify the knowledge' and belief (perceived threat, perceived self-efficacy, perceived benefit, and perceived barrier) of healthcare professionals regarding antibiotic stewardship to be able to design training to meet their needs.

2. Methods

This research was an observational descriptive study with a cross-sectional design. The research material was drawn from a questionnaire completed by healthcare professionals in a private hospital in Surabaya and two public hospitals in Mojokerto and Pasuruan. The

questionnaire was developed and validated with the different respondents at the respective hospital before collecting the data. The Kuder Richardson 20 (KR-20) for the knowledge and Cronbach's alpha values for the belief, of the questionnaire were 0.54 and 0.92, respectively. Participants are healthcare practitioners who are associated with antibiotic prescribing and use. The professions included in this study are doctors, pharmacists, midwives, the AMS team members, nurses. The excluded professions are psychiatrists, radiologists, obstetric and neonatal nurses, and hemodialysis nurses. The minimum sample size (n) required is 24 respondent; based on the formula below, where n is the minimum sample size, the Z value for $p < 0.05$ is 1.96, the unknown population size (P) is 0.5, and to obtain 0.2 effect difference (d) [22].

The research questionnaire was delivered face-to-face or collected by the chief nursing officer in the hospital. The respondents provided a written consent, after they understood the research objective and agree to participate; and answered the research questionnaire. The questionnaire consisted of 43 questions (Appendix 1). Of these, 12 questions were used to assess knowledge, and 31 questions to assess belief. The 31 belief questions consisted of 10 questions to assess perceived threats, 11 questions to assess perceived self-efficacy, 8 questions to assess perceived benefits, and 2 questions to assess perceived barriers. The responses to the knowledge questions were measured using the Guttman scale, which specifies a Yes or No answer. The maximum score of the knowledge questionnaire was 12, whereas the belief questionnaire was measured using a 5-point Likert scale. The belief score was a composite score (31 item questions; maximum score 155) which included the perceived threat score (10 item questions; maximum score 50), perceived self-efficacy score (11 item questions; maximum score 55), perceived benefit score (8 item questions; maximum score 40), and perceived barrier score (2 item questions; maximum score 10). There were three categories: high, moderate, and low. The number of respondents in the high category was the number of respondents who had scores higher than the mean value \pm one standard deviation (SD). The number of the respondents in the moderate knowledge or belief category was the number of respondents who had scored in the range of mean value \pm one SD. Any respondent with a score lower than the moderate category's score (mean value \pm one SD) was counted in the low category. We performed a simple random data collection (probability sampling) for nurses' groups (65 nurses from 406 nurses) and complete data collection (nonprobability-sampling) for other groups of professions to get a proportionate number among groups. This study is a descriptive analysis to statistically describe the knowledge and belief score. The healthcare professional's knowledge and belief differences were analyzed with the Kruskal-Wallis test because the data are not normally distributed.

2.1. Ethical considerations

All procedures performed involving human participants were done in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Written consent to participate was obtained from each study participant. The study was approved by the respective hospital managements (Surabaya city: No. 1299/RSHU/Dir./X/2017; Mojokerto district: No. 423.4/4882/416-207/2017; and Pasuruan district: No. 455.1/2752/424.202/2017) and was conducted in accordance with the Indonesian Law for the Protection of Personal Data. The study was ethically cleared by the Health Research Ethics Committee of Politeknik Kesehatan Kemenkes Surabaya, Kementerian Kesehatan No.025/S/KEPK/V/2017.

3. Results

The study population consisted of representatives from five professions: nurses, midwives, pharmacists, pharmacy technicians, and physicians. Table 1 shows the baseline characteristics of the respondents. At a private hospital in Surabaya city, the response rate was 83% (245/

Table 1. Baseline characteristics of healthcare practitioners.

Variable	Professions (N = 257)										
	Nurses (n = 65)		Midwives (n = 61)		Pharmacists (n = 27)		Pharmacy technicians (n = 45)		Physicians (n = 59)		
	n	%	n	%	n	%	n	%	n	%	
Gender	Female	48	74	61	100	25	93	43	96	30	51
	Male	17	26	-	-	2	7	2	4	29	49
Work experience	≤3 years	10	15	7	11	16	59	7	16	15	25
	>3 years	55	85	54	89	11	41	38	84	44	75

296), and 179 met the inclusion and exclusion criteria; at a public hospital in Mojokerto district, the response rate was 77% (153/200), and 153 met the inclusion and exclusion criteria; and at a public hospital in Pasuruan district, the response rate was 87% (307/352), and 257 met the inclusion and exclusion criteria. There were 65 nurses, 61 midwives, 27 pharmacists, 45 pharmacy technicians, and 59 physicians included in the analysis.

Nineteen percent (48/257) of the respondents had low scores (below mean value ± one SD) knowledge about antimicrobial stewardship (Table 2). The mean of antibiotic stewardship knowledge of total respondents was 9.9 (1.5) (Table 3, Figure 1). The mean of antibiotic stewardship knowledge of the pharmacist and physicians was higher than that of the pharmacy technicians, nurses, and midwives.

The physicians had a high score of perceived threat, perceived self-efficacy, perceived benefit, and an average score of perceived barrier compared with other professions. The pharmacists had a high score for perceived threat and perceived barrier and a low score for perceived self-efficacy and perceived benefit compared with other professions (Table 4). The total score knowledge and belief healthcare professionals differences were statistically significant (p < 0.05).

Work experience affected the knowledge (p = 0.07) and belief (p = 0.001) of the pharmacists significantly, but the Kruskal–Wallis test showed that the association between work experience and knowledge or belief of other professions (nurses, midwives, pharmacy technicians, and physicians) was not significant.

4. Discussion

Knowledge about antibiotic stewardship varies among different groups of healthcare practitioners. The lack of knowledge may cause inappropriate use of antibiotics. However, antibiotic stewardship knowledge can be increased with education and training. A study in Dire

Dawa, Ethiopia with a total of 218 paramedical staffs (41 health officers, 96 nurses, 31 pharmacists, 21 midwives, and 29 medical laboratory technologists) showed that the level of knowledge about the causes of antimicrobial resistance for the pharmacists (77.4%), health officers (75.6%), and nurses (63.5%) was higher than that of lab technologists (44.8%) and midwives (38.1%). That study also showed that 90.4% (197/218) had not attended any training on antimicrobial resistance; that 96.8% (211/218) of the participants of the study had not used antimicrobial sensitivity test results for treating the patients, and that only 15.7% of them reported referring to the guidelines whenever caring for a patient [23]. Along with education and training, capabilities of healthcare practitioners will also increase. A study on long-term educational effects of antibiotic prescribing in 171 doctors showed that antibiotic prescribing in the intervention group was reported as having a more significant decrease compared with that in the control group. There were two intervention subgroups. First, a 2-day seminar about evidence-based medicine for respiratory infections (evidence-based medicine subgroup). Second, an additional 1-day seminar focused on problem-solving strategies (evidence-based medicine plus problem-solving strategies subgroup) [24]. The studies indicated that the education about the benefits of limiting antibiotic use is urgently needed for healthcare professionals [25,26]. These findings will be used by hospital management to design better educational material for the next antibiotic stewardship training for healthcare professional that associated with antibiotic use.

There are differences in knowledge and belief among healthcare professionals. There is a positive correlation between knowledge and behavior. The knowledge about antibiotic stewardship will affect antibiotic use behavior. Furthermore, there is a positive correlation between self-efficacy and perceived benefit, and a negative correlation between self-efficacy and perceived barrier [16]. Nair et al. reported that there was a statistically significant difference in average scores of knowledge,

Table 2. The respondent knowledge classification.

Classification	Professions (N = 257)											
	Nurses (n = 65)		Midwives (n = 61)		Pharmacists (n = 27)		Pharmacy technicians (n = 45)		Physicians (n = 59)		Total (N = 257)	
	n	%	n	%	n	%	n	%	n	%	n	%
High	0	0	0	0	0	0	0	0	0	0	0	0
Moderate	54	83	36	59	26	96	42	93	51	86	209	81
Low	11	17	25	41	1	4	3	7	8	14	48	19

Table 3. The descriptive statistics (N = 257).

Variable	Mean	Standard deviation	Minimum	Maksimum	N of item question (maximum scores)
Knowledge	9.85	1.532	3	11	12 (12)
Belief	118.41	8.933	97	151	31 (155)
Threat	37.77	5.418	25	50	10 (50)
Self-efficacy	41.86	3.891	28	54	11 (55)
Benefit	31.68	2.880	14	40	8 (40)
Barrier	7.10	1.217	4	10	2 (10)

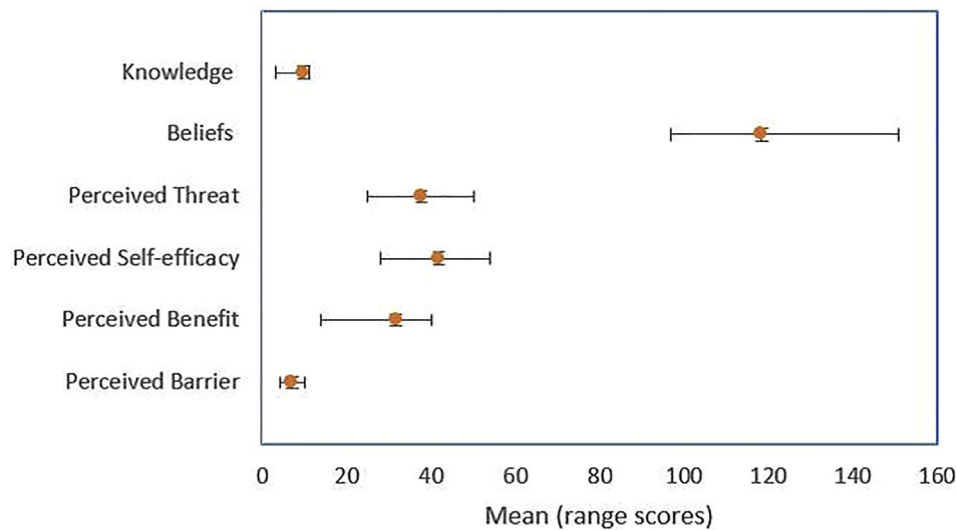


Figure 1. Mean scores of variables.

attitude, and practice questions among allopathic doctors, nurses, pharmacy shopkeepers, and informal health providers in Paschim Bardhaman District, India [27]. A study of 135 nurses from two hospitals in Mashhad, Iran showed that education intervention in the intervention group increased the participants' knowledge, and that there was a significant relationship between knowledge and perceived threat or perceived benefit [17]. A study of the HBM as an explanatory framework in communication research recommended further research to evaluate the

causal effect of the behavior variable and which variable was a strong predictor of behavior change [15].

Education is effective in reducing antibiotic prescribing, but education combined with direct intervention in supporting the implementation of rational antibiotic use is more effective than education alone [28,29]. Some interventions identified were public awareness campaigns [26], antimicrobial guidelines [30], professional regulation [31], restricted reimbursement [32], pay for performance, and prescription requirements [32,33]. Collaborative practice and recommen-

Table 4. The respondent belief classification.

Category	Professions (N = 257)										Total	
	Nurses (n = 65)		Midwives (n = 61)		Pharmacists (n = 27)		Pharmacy technicians (n = 45)		Physicians (n = 59)		n	%
	n	%	n	%	n	%	n	%	n	%		
Belief												
Strong	5	8	2	3	4	15	1	2	10	17	22	9
Moderate	54	83	13	21	9	33	13	29	45	76	134	52
Weak	6	9	46	75	14	52	31	69	4	7	101	39
Perceived Threat												
High	4	6	0	0	5	19	0	0	18	31	27	11
Moderate	55	85	41	67	22	81	41	91	40	68	199	77
Low	6	9	20	33	0	0	4	9	1	2	31	12
Perceived Self-efficacy												
High	14	22	7	11	3	11	1	2	8	14	33	13
Moderate	50	77	54	89	20	74	44	98	51	86	219	85
Low	1	2	0	0	4	15	0	0	0	0	5	2
Perceived Benefit												
High	9	14	4	7	0	0	0	0	7	12	20	8
Moderate	52	80	54	89	19	70	39	87	50	85	214	83
Low	4	6	3	5	8	30	6	13	2	3	23	9
Perceived Barrier												
High	7	11	9	15	7	26	0	0	8	14	31	12
Moderate	55	85	48	79	20	74	45	100	48	81	216	84
Low	3	5	4	7	0	0	0	0	3	5	10	4

dation acceptance by the clinical provider is also important for an antibiotic stewardship program [34] and for collaborative approaches to appropriate antimicrobial use [35]. Logan's study in 28 hospitals showed that collaborative practice in antibiotic stewardship increased days of therapy (DOT) per 1,000 patient-days of broad-spectrum antibiotics reduction from 1%–2.5% to 5%–10% [36].

In this study, the association of work experience and the knowledge or belief were inconsistent. Among the pharmacists' subgroup, the work experience was associated with different score knowledge or belief, but among other professions (nurses, midwives, pharmacy technicians, and physicians) subgroup, the work experience was not associated with the knowledge or belief score. These results are comparable to the findings reported by Tegnagn et al. from a study in Fitcha Hospital, Ethiopia, where profession and years of experience were not significant predictors of healthcare professionals' knowledge, attitude, and practices towards antimicrobial stewardship [18].

Our study has a number of limitations. First, it is not fully representative for the sample population because not all healthcare practitioners filled in the questionnaire. This is the nonresponse error, reflecting the results of the individuals who did not respond to the survey. Second, there is measurement error, occurring when survey responses are not accurate reflections of the true value because of social desirability bias [37].

5. Conclusion

Among healthcare professionals, knowledge and belief differences of antibiotic stewardship vary widely. Antibiotic knowledge is associated with positive belief and behavior that contribute to adherence to a judicious use of antibiotics and reduce antibiotic utilization. Knowledge about antibiotics and resistance relates to the understanding of the antibiotic misuse concept and awareness of antimicrobial resistance. The Health Belief Model (HBM) theory presume several constructs (perceived severity, perceived benefit, self-efficacy, cues of action) to predict behavior. Perception about the severity and consequences of the disease and the benefits of antibiotic treatment for infectious disease are determinants of antibiotic use and prescribing behavior [15]. Further studies are needed to evaluate the correlation between the level of interprofessional collaboration and the quality of the antibiotic stewardship implementation.

Declarations

Author contribution statement

Fauna Herawati and Diantha Soemantri: Conceived and designed the experiments; Wrote the paper.

Abdul Kadir Jaelani and Heru Wijono: Performed the experiments.
 Setiasih: Analyzed and interpreted the data.
 Rika Yulia: Analyzed and interpreted the data; Wrote the paper.
 Abdul Rahem: Contributed reagents, materials, analysis tools or data.
 Retnosari Andrajati: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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Appendix

Appendix 1: Knowledge and belief questionnaire RESPONDENT PROFILE

- Age:
- Gender:
- Profession:
- Profession length:
- Work place (unit/division):

Number	Statement	True	False
1.	<i>Penggunaan antibiotik yang tidak sesuai dengan indikasi, menyebabkan bakteri resisten terhadap antibiotik.</i> The use of antibiotics outside the indications, causes bacteria to become resistant to antibiotics.		
2.	<i>Frekuensi pemberian antibiotik yang tidak tepat dengan waktu minum obat tersebut dapat menyebabkan bakteri resisten terhadap antibiotik.</i> The inappropriate administration of antibiotic can cause bacterial resistant to antibiotics.		
3.	<i>Pemilihan antibiotik yang tidak sesuai dengan jenis infeksi, menyebabkan bakteri resisten terhadap antibiotik.</i> The selection of antibiotics that are not related to the type of infection, causes bacteria to become resistant to antibiotics.		
4.	<i>Pemantauan dan evaluasi penggunaan antibiotik cukup dilakukan oleh perawat saja.</i> Monitoring and evaluation of the use of antibiotics are performed by nurses only.		
5.	<i>Penggunaan dosis antibiotik yang kurang dari dosis terapi dapat menyebabkan bakteri resisten terhadap antibiotik.</i> The use of doses of antibiotics lower than the therapeutic dose can cause bacteria to become resistant to antibiotics.		
6.	<i>Penggunaan dosis antibiotik yang lebih dari dosis terapi dapat meningkatkan efek samping obat.</i> The use of doses of antibiotics that are higher than the therapeutic dose can increase the side effects of the drug.		

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Number	Statement	True	False
7.	<i>Pemberian informasi penggunaan antibiotik kepada pasien dapat mencegah bakteri resisten terhadap antibiotik.</i> Providing information on the use of antibiotics to patients can prevent bacteria becoming resistant to antibiotics.		
8.	<i>Peta kuman di rumah sakit dapat membantu mengetahui bakteri yang resisten terhadap antibiotik.</i> Antibiotic sensitivity patterns in the hospital can help to identify antibiotic-resistant bacteria.		
9.	<i>Lama pemberian antibiotik yang tidak sesuai dengan jenis infeksi, menyebabkan bakteri resisten terhadap antibiotik.</i> The duration of antibiotic administration not following the type of infection, may cause bacteria to become resistant to antibiotics.		
10.	<i>Cara pemberian antibiotik yang tidak sesuai dengan aturan dapat menyebabkan bakteri resisten terhadap antibiotik.</i> Give antibiotics without following the rules can cause bacteria to become resistant to antibiotics.		
11.	<i>Pelaksanaan Program Pengendalian Resistensi Antibiotik (PPRA) cukup dilakukan oleh dokter saja.</i> The implementation of the Antibiotic Resistance Control Program (PPRA) can only be done by a doctor.		
12.	<i>Mencuci tangan sebelum dan sesudah kontak fisik/penyiapan sediaan injeksi kepada pasien dapat mengurangi transmisi/penularan penyakit infeksi.</i> Washing hands before and after physical contact/preparing injections to patients can reduce the transmission of infectious diseases.		

Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	<i>Pemberian antibiotik pada bakteri yang resisten terhadap antibiotik tersebut dapat memperpanjang lama rawat inap.</i> Giving antibiotics to bacteria that are resistant to antibiotics can prolong the length of hospitalization.					
2.	<i>Bakteri resisten terhadap antibiotik dapat meningkatkan biaya pengobatan pada pasien yang terinfeksi.</i> Antibiotic-resistant bacteria can increase treatment costs in infected patients.					
3.	<i>Bakteri resisten terhadap antibiotik meningkatkan frekuensi pemeriksaan laboratorium pada pasien yang terinfeksi.</i> Antibiotic-resistant bacteria increase the frequency of laboratory tests in infected patients.					
4.	<i>Bakteri resisten terhadap antibiotik dapat menyebabkan terjadinya sepsis.</i> Bacterial resistance to antibiotics can cause sepsis.					
5.	<i>Bakteri resisten terhadap antibiotik dapat menyebabkan risiko pasien dirawat di intensive care unit (ICU) atau ruang isolasi.</i> Bacterial resistance to antibiotics can put the patient at risk of being admitted to the intensive care unit (ICU) or isolation room.					
6.	<i>Bakteri resisten terhadap antibiotik dapat meningkatkan risiko mortalitas pada pasien yang terinfeksi.</i> Antibiotic-resistant bacteria can increase the risk of mortality in infected patients.					
7.	<i>Profesi saya beresiko terinfeksi bakteri yang resisten terhadap antibiotik.</i> My profession is at risk of infection with antibiotic-resistant bacteria.					
8.	<i>Penggunaan kombinasi antibiotik karena bakteri resisten dapat meningkatkan efek samping obat.</i> The use of a combination of antibiotics due to resistant bacteria can increase the side effects of the drug.					
9.	<i>Bakteri resisten terhadap antibiotik dapat menyebabkan risiko penggunaan ventilator pada pasien yang terinfeksi.</i> Antibiotic-resistant bacteria may pose a risk of ventilator use in infected patients.					
10.	<i>Bakteri resisten terhadap antibiotik membebani keuangan negara dalam pembiayaan jaminan kesehatan nasional.</i> Antibiotic-resistant bacteria burden the state's finances in financing national health insurance.					
11.	<i>Laboratorium mikrobiologi di rumah sakit saya dapat mendukung keberhasilan Program Pengendalian Resistensi Antibiotik (PPRA).</i> The microbiology laboratory at my hospital can support the success of the Antibiotic Resistance Control Program (PPRA).					
12.	<i>Penjelasan saya tentang penggunaan antibiotik dapat dipahami pasien.</i> My explanation about the use of antibiotics is understandable for the patient.					
13.	<i>Saya berkoordinasi dengan tenaga kesehatan lain ketika pasien mendapatkan antibiotik bersamaan dengan obat lain.</i> I attune with other healthcare practitioners when patients receive antibiotics along with other drugs.					
14.	<i>Pencampuran (rekonstitusi) sediaan antibiotik dilakukan dengan baik di rumah sakit saya.</i> Mixing (reconstitution) of antibiotic preparations is done well in my hospital.					

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Number	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15.	<i>Saya mengkonfirmasi peresepan/cara penggunaan antibiotik sebelum diberikan ke pasien dengan tenaga kesehatan lain.</i> I confirm the prescribing/how to use antibiotics before giving them to patients with other healthcare practitioners.					
16.	<i>Farmasis di rumah sakit saya menjamin stabilitas hasil pencampuran sediaan antibiotik.</i> The pharmacists in my hospital guarantee the stability of the reconstituted antibiotic preparations.					
17.	<i>Saya mengganti antibiotik bila hasil laboratorium menunjukkan bakteri resisten terhadap antibiotik meskipun kondisi klinik membaik.</i> I change antibiotics when the laboratory results show that bacteria are resistant to antibiotics even though the clinical condition is improving.					
18.	<i>Pedoman Penggunaan Antibiotik (PPAB) di rumah sakit saya telah digunakan sebagai pedoman dalam penggunaan antibiotik.</i> The Antibiotic Use Guideline (PPAB) in my hospital have been used as guidelines in the use of antibiotics.					
19.	<i>Formularium rumah sakit saya telah memberi batasan (restriksi) yang jelas tentang penggunaan antibiotik.</i> My hospital formulary has clearly defined the use of antibiotics.					
20.	<i>Farmasis di rumah sakit saya merekomendasikan perubahan antibiotik parenteral ke oral jika kondisi pasien membaik.</i> The pharmacists in my hospital recommends changing parenteral to oral antibiotics if the patient's condition improves.					
21.	<i>Saya melanjutkan antibiotik bila kondisi klinik pasien membaik setelah 48–72 jam.</i> I continue antibiotics if the patient's clinical condition improves after 48–72 h.					
22.	<i>Penggunaan antibiotik di rumah sakit saya rasional (sesuai indikasi, tepat dosis, frekuensi, rute pemberian dan lama terapi).</i> The use of antibiotics in my hospital is rational (according to indication, dosage, frequency, route of administration, and duration of therapy).					
23.	<i>Penggunaan antibiotik pada pasien dapat dipantau/dievaluasi dengan baik.</i> The use of antibiotics in patients can be monitored/evaluated properly.					
24.	<i>Tenaga kesehatan di rumah sakit saya dapat memilih dan merekomendasikan antibiotik dengan baik.</i> The healthcare practitioners in my hospital are well able to choose and recommend antibiotics.					
25.	<i>Pedoman Penggunaan Antibiotik (PPAB) di rumah sakit saya diperbarui secara berkala.</i> The Antibiotic Use Guideline (PPAB) in my hospital are updated regularly.					
26.	<i>Pemeriksaan laboratorium untuk pasien yang terinfeksi diperiksa sesuai kebutuhan.</i> Laboratory tests for infected patients are checked as needed.					
27.	<i>Koordinasi antar tenaga kesehatan (dokter, perawat, apoteker) yang baik mendukung keberhasilan terapi.</i> Good coordination between healthcare practitioners (doctors, nurses, pharmacists) supports the success of therapy.					
28.	<i>Pembatasan penggunaan antibiotik oleh formularium rumah sakit menurunkan kejadian bakteri resisten terhadap antibiotik.</i> Restrictions on the use of antibiotics by hospital formularies reduce the incidence of antibiotic-resistant bacteria.					
29.	<i>Penggantian antibiotik dari spektrum luas ke spektrum lebih sempit sesuai penyebab infeksi menurunkan kejadian bakteri resisten terhadap antibiotik.</i> Switching from broad-spectrum to narrower-spectrum antibiotics according to the cause of infection reduces the incidence of antibiotic-resistant bacteria.					
30.	<i>Pengetahuan tentang bakteri yang resisten dapat membantu keberhasilan terapi.</i> Knowledge of resistant bacteria can help in successful therapy.					
31.	<i>Waktu pemeriksaan yang lama di laboratorium mikrobiologi tidak berpengaruh pada keberhasilan terapi pada pasien yang terinfeksi.</i> Long examination time in microbiology laboratory has no effect on the success of therapy in infected patients.					

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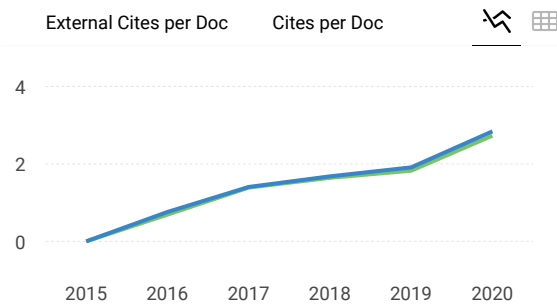
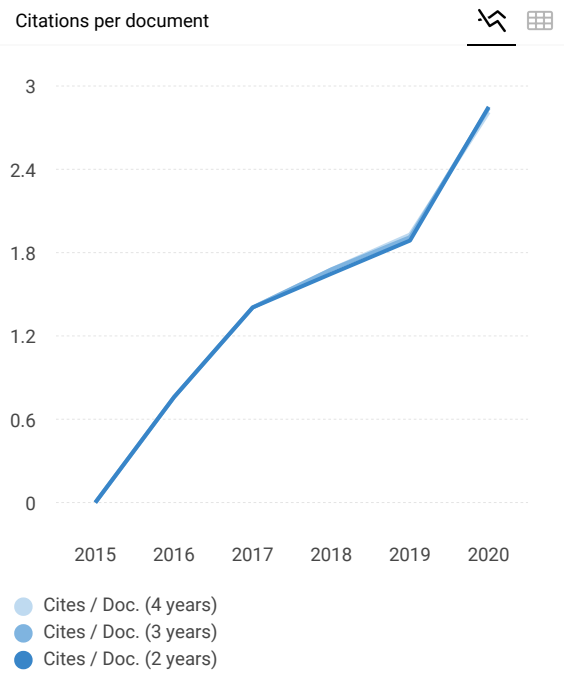
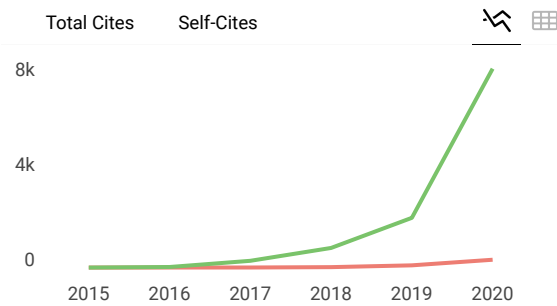
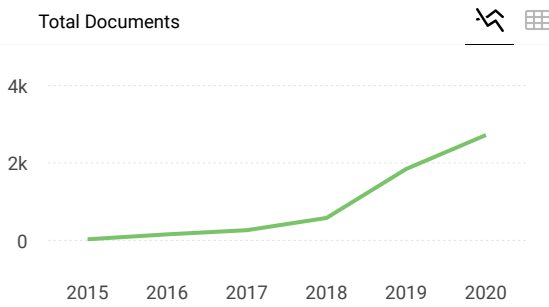
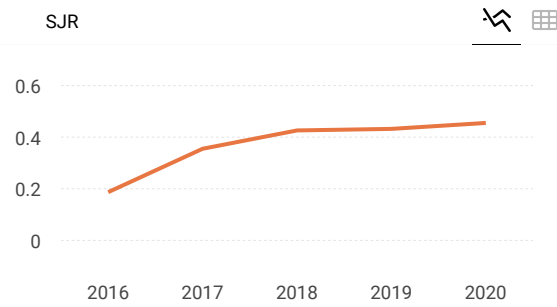
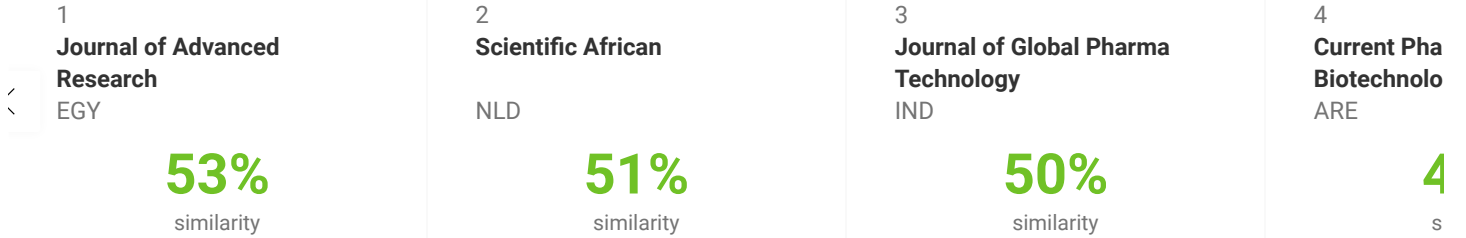
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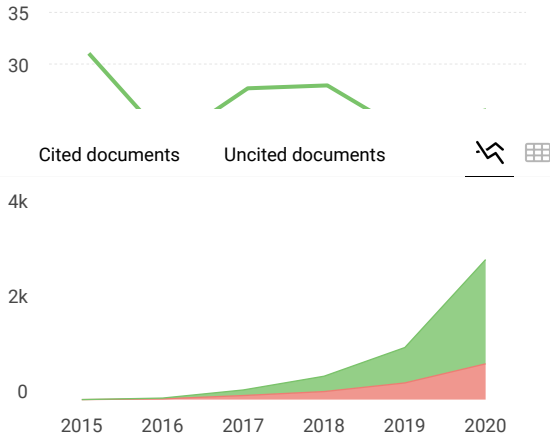
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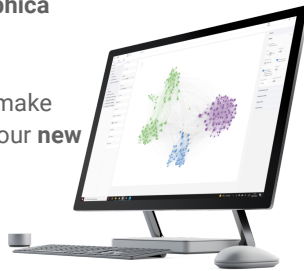
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M **M.Shravanthi Bandari** 2 weeks ago

Hello,

Can I know if Heliyon is in UGC approved 2020-2021 journal's list and can I know it's IF.

reply



Melanie Ortiz 1 week ago

SCImago Team

Dear M.Shravanthi , thank you very much for your comment. SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. We suggest you consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science

data source.
Best Regards, SCImago Team

A **Ajmal Hameed** 3 weeks ago

Dear

How can I submit my paper to this journal? pleas send me the procedure.

Thank you,
Ajmal

reply



Melanie Ortiz 1 week ago

SCImago Team

Dear Ajmal, thank you very much for your comment, we suggest you look for the author's instructions/submission guidelines in the journal's website. Best Regards, SCImago Team

A **Asmaa** 1 month ago

Is this journal free for Egypt?

reply



Melanie Ortiz 1 month ago

SCImago Team

Dear Asmaa,
Thank you for contacting us.
Unfortunately, we cannot help you with your request, we suggest you visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

D **Dr. Md. Ismail Hossain** 1 month ago

APC for this journal showing USD 1750. How can I ger wave for this APC? Please let me know asap.

reply

N **Nur Hasan Mahmud Shahen** 3 weeks ago

Dear,

What country do you belong? If its type C country then its autometricly reduced.
or If you can write to the head of Elsevier publisher then they can minimize it.

Please go to the journal APC process for more details.
Thank you.

SCImago Team

**Melanie Ortiz** 1 month ago

Dear Dr. Md. Ismail, thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact the journal's editorial staff so they could inform you more deeply. Best Regards, SCImago Team

Z **zainal hasan** 2 months ago

In the near future, I will submit it to this journal. best regards...aez hasan

reply

SCImago Team

**Melanie Ortiz** 2 months ago

Dear Zainal, thanks for your participation! Best Regards, SCImago Team

M **Mohamed E. Hasan** 2 months ago

what is the impact factor of this journal?

reply

SCImago Team

**Melanie Ortiz** 2 months ago

Dear Mohamed, thank you very much for your comment. SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR (Check it on our website). We suggest you consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

O **Omolara** 3 months ago

Please tell us the publication fee

reply

SCImago Team

**Melanie Ortiz** 3 months ago

Dear Omolara,
Thank you for contacting us.
Unfortunately, we cannot help you with your request, we suggest you visit the journal's

homepage or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

W **wasim bari** 4 months ago

In heliyon journal what is the time to decision after submit the paper correction according to reviewer question?

reply



Melanie Ortiz 4 months ago

SCImago Team

Dear Wasim,

Thank you for contacting us. Please see comments below.

Best Regards, SCImago Team

C **Cristian Torres** 4 months ago

When will Heliyon have the impact factor calculated? Is there an estimated date?

reply



Melanie Ortiz 4 months ago

SCImago Team

Dear Cristian, thank you very much for your comment. SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR (Check it on our website). We suggest you consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

M **Mark** 5 months ago

It is an unreliable journal. A year after sending my manuscript, they told me that it was initially accepted, there were minor revisions, I made the respective corrections, six months passed and they did not give me a response. I sent my manuscript to another journal and in four months they accepted it without a publication charge and it is also Q1.

reply

M **Magdy Fouad** 1 month ago

Dear Mark

Can you tell me the name of the journal that accept your paper in 4 months please?

I need rapid publication in Q1 journal for my upgrading.

Thanks



Mey 5 months ago

Hi, Mark! I wonder if you can share here the second journal where you submitted your manuscript. It's interesting that a Q1 journal responds and decides in 4 months.

D Dyg 5 months ago

Hi Mark...just curious which journal did you submit the second and got accepted...it is Q1 and no charge...that is good..

U unkown 5 months ago

I am having a similar problem like mark. I submitted my paper in July 2020. They gave me major revisions to do after 4 months. After I made the respective corrections and resubmitted the revised one in December. After 2 months they told me decision is under process. After few days status changed to decision rescinded. Now the new status is showing as reviewer invited. I am wondering what will be the future of my paper with this journal. Any suggestions will be highly appreciated. Kindly suggest me how to expedite with this journal. Please. What should be the best way to do as of now

M Mahmud 5 months ago

You could just mail them. They respond very frequently. Moreover, many of the journals take too much time in publishing papers. Sometimes, reviewers delay for personal reasons.

If you face a similar problem, I recommend you to mail them.



Melanie Ortiz 5 months ago

SCImago Team

Dear Mark, thanks for your participation! Best Regards, SCImago Team

B Biyanu Medenes Zerom 6 months ago

What is the JIF (Journal Impact factor) of this journal

reply

E Ebtesam 6 months ago

Journal Impact factor of this journal is still not calculated, it is indexed in WOS, Emerging citation index source which means that the journal has been already in WOS but didn't get IF yet. But it is a growing journal. Its citation is increasing in a good way.



Melanie Ortiz 6 months ago

SCImago Team

Dear Biyanu, thank you very much for your comment. SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR (Check it on our website). We suggest you consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

N Nazmul 7 months ago

Is Heliyon a good journal? How many issues does it publish in a year?

reply



Melanie Ortiz 7 months ago

SCImago Team

Dear Nazmul,

Thank you for contacting us. You can check the scientometric indicators for Heliyon just above. For further information about the publication frequency, please consult its website.

Best Regards, SCImago Team

M Mohamed 9 months ago

Hello,
Does this journal is indexed as ISI journal

Thank you in advance

reply

E Ebtesam 6 months ago

Yes, it is indexed.

L Lanfranco Corazzi 7 months ago

Dear team,
when Heliyon will be mentioned by WOS (WEB OF SCIENCES) in the Journal Citations Reports?
Many thanks for your reply.
Lanfranco Corazzi



Melanie Ortiz 7 months ago

SCImago Team

Dear Lanfranco,

Thank you for contacting us . Unfortunately, we cannot help you with your request,

we suggest you contact WoS Team.

Best Regards, SCImago Team



Melanie Ortiz 9 months ago

SCImago Team

Dear Mohamed,
Thank you for contacting us.
SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus. Unfortunately, we cannot help you with your request referring to the index status. We suggest you consult Scopus database (see the current status of the journal) or the mentioned database for further information. You can also check that information in the journal's website or contact directly with the editorial staff.
Best Regards, SCImago Team

A **aspirant eagle** 1 year ago

- what does the quartile mean? What is it's importance?
-And Why the journal quartile her is Q1 but in the scoups is Q2?

Thanks

reply



Melanie Ortiz 1 year ago

SCImago Team

Dear Sir/Madam,

Thank you for contacting us.

Our data come from Scopus, they annually send us an update of the data. This update is sent to us around April / May every year.

The calculation of the indicators is performed with the copy of the Scopus database provided to us annually. However, the methodology used by Scopus is different from the one's used by SCImago, even if, since the past year, the scientometrics indicators' calculation procedure changed in order to resemble SciVal.

In the case of SCImago, for every journal, the annual value of the SJR is integrated into the distribution of SJR values of all the thematic categories to which the journal belongs.

There are more than 300 thematic categories; the position of each journal is different in any category and depends on the performance of the category, in general, and the journal, in particular .

The SJR indicator is a very sophisticated indicator that is much more complex to calculate and understand than the Impact Factor. Several variables must be taken into account to calculate the SJR. There are two important variables that we cannot leave out:

-The number of citations is one of those variables but not the only one because it is weighted by the citations received and where the journal is cited in. It is different if the citations come from highly-cited Journals or not. Imagine that these 5 quotes appear in the most cited Journals. That part of the calculation is no longer worth 5, it is worth much more. This variable is called "authority principle".

-The second variable is the thematic Category's distribution. If most of the journals categorized in X thematic category are cited by lowly-cited journals, the quartile of a journal cited in highly-cited journals will be better than the other ones.

Best Regards, SCImago Team

D **Daniel Bravo** 1 year ago

Dear Editors team,

I would like to know what is the frame-time to the first answers of revision (in weeks). All the very best.

reply



Melanie Ortiz 1 year ago

SCImago Team

Dear Daniel,
thank you for contacting us.
Unfortunately, we cannot help you with your request, we suggest you visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

K **kahsu Atsbha** 1 year ago

What is the difference between Heliyon cell press and heliyon Elsevier? Are they the same or not?

reply

R **Rocktim R Das** 9 months ago

Thanks, Kahsu,

I too was thinking about this issue, In the online HTML I see the Elsevier logo and Cell press, but when downloading the pdf only the cell press logo is present. One possibility might be that the journal is published by Cell press but hosted by Elsevier in Science direct.com. Apart from that, I don't have much clue.

Sincerely
Rocktim



Melanie Ortiz 1 year ago

SCImago Team

Dear Kahsu,
Thank you for contacting us. Could you please expand a little bit your comment? Do these journals have different ISSN numbers? Best Regards, SCImago Team

H **Hesti Maheswari** 1 year ago

Is the Heliyon journal still indexed by Scopus in 2019?

reply

R **Rocktim R Das** 9 months ago

Yes.

A **Achmad Fanani** 12 months ago

Masih



Melanie Ortiz 1 year ago

SCImago Team

Dear Hesti, thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you to consult the Scopus database directly. Keep in mind that the SJR is a static image (the update is made one time per year) of a database (Scopus) which is changing every day.

Best Regards, SCImago Team

F **Frank** 1 year ago

That is not the scope of the journal. Change it to the scope...

<https://www.cell.com/heliyon/home>

"Heliyon is an open access journal publishing scientifically accurate and valuable research across life, physical, social, and medical sciences."

reply



Melanie Ortiz 1 year ago

SCImago Team

Dear Frank,

thank you for contacting us. The Scope's information has been updated based on what appears in the journal's website (check here: <https://www.cell.com/heliyon/aims-and-scope>) Best Regards, SCImago Team

G **GsmA** 2 years ago

Thanks...

reply

G **GsmA** 2 years ago

Hi,

Just I want to ask about the fees to publish in the journal, can you help me?

reply



Melanie Ortiz 2 years ago

SCImago Team

Dear Sir,

thank you for contacting us.

Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.

Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.

Best Regards, SCImago Team

A **Ali** 2 years ago

Dear All,

I hope anybody knows about the speed of response and decision it takes to let us know about it.

Best Regards,

reply

S **Sintayehu** 5 months ago

I published one paper on Heliyon Social Sciences and another one is just accepted for publication. They announce the first review result in 90 days. I found the review process a little bit slow but very thorough and helps a lot to improve the original work. Preliminary decision for publication will be communicated one month after the submission of the revised version of the work. Final decision of publication will be announces after two weeks. In total, it took six months to publish.

H **Hamzeh Ghahramani** 1 year ago

They gave me the first decision after 3 week with a meticulous review of my manuscript



Melanie Ortiz 2 years ago

SCImago Team

Dear Ali, thanks for your participation! Best Regards, SCImago Team

K **Khaled Karam** 2 years ago

Hi,

Is this journal published in print or online only?

Thanks for your consideration

reply



Melanie Ortiz 2 years ago

SCImago Team

Dear user,
thank you for contacting us.
We suggest you to visit the journal's homepage.
You can see the updated journal's information just above .
Best Regards, SCImago Team

D Dan 2 years ago

This journal was started in 2015. It has achieved scopus Q1 rank because this is Elsevier's own journal. It is also indexed in ESCI. I can see that publishing giants have their own journals indexed with their own databases. Other journals would take years to get indexed in such databases. It all about money. Cheers!

reply

R Rhys 1 year ago

I believe this is a Cell Press Journal rather than Elsevier <https://www.cell.com/heliyon/home>



Melanie Ortiz 2 years ago

SCImago Team

Dear Dan, thanks for your participation! Best Regards, SCImago Team

M Mahesh Kumar Tripathi 2 years ago

Hello Elena,
Please tell me.....
Is Heliyon SCI journal?
When it will get impact factor?

reply



Melanie Ortiz 2 years ago

SCImago Team

Dear Mahesh, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our web to locate the journal. We suggest you to consult the Journal

Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

H **Hossein Sabahi** 2 years ago

Dear Editor
how many is the charge for publication a article ?

Sincerely
Dr. H. Sabahi

reply

M **Messali** 2 years ago

1750 USD



Melanie Ortiz 2 years ago

SCImago Team

Dear Hossein,
thank you for contacting us.
Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.
You can see the updated journal's information just above .
Best Regards, SCImago Team

Z **Zemenu Bires** 2 years ago

in which index Heliyon is indexed? would you tell me please?

reply



Melanie Ortiz 2 years ago

SCImago Team

Dear user, we suggest you to consult that information in the journal's website. You can also consult the Scopus database directly. Best Regards, SCImago Team

Z **Zemenu Bires** 2 years ago

Would you mind telling me about Heliyon journal in which it is indexed; Scopus, SCI, ISI-index/Scopus or any index?

reply



Melanie Ortiz 2 years ago

Dear user, we suggest you to consult the journal's website or Scopus database directly. For other indicators like ISI or Impact Factor, we suggest you to consult the Journal Citation Report with a Web of Science data source. Best Regards, SCImago Team

S **Santosh** 2 years ago

Hi,

Can you please tell when Heliyon expected will get impact factor (will come under sci or esci)?

reply



Melanie Ortiz 2 years ago

Dear user, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our web to locate the journal. We suggest you to consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

D **Deni** 3 years ago

Dear Elena, How long has Heliyon released the article, I have submitted?

reply



Elena Corera 3 years ago

Dear Deni,

thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you look for author's instructions in the journal's website.

Best Regards,

SCImago Team

S **SIFI** 3 years ago

what are the favorite and targeted topics in this journal?

reply

A **Ali** 3 years ago

Hello,

I read in your website that this journal is not free of charge for publication. let me know that is it

true?

thanks.

reply



Elena Corera 3 years ago

SCImago Team

Dear Ali,

Please, check comments below.

Best regards,
SCImago Team

H **Harjali** 3 years ago

Nice to meet you, could you give me detail information of Heliyon Journal? I have checked it at SJR that this journal has 7 H Index and Q1, It is right?. thank you very much.

Best regards

Harjali

reply

F **Foad buazar** 3 years ago

Hi

I wonder how a journal like Heliyon Rank Q1 but without impact factor?

I am really confused. Would you please clarify the vague feeling of authors concerning this notion?

Thank you

reply



Elena Corera 3 years ago

SCImago Team

Dear Foad,

you can check impact factor in SJR website.

Best regards,
SCImago Team

A **Achmad Herman** 3 years ago

Dear Colleagues

I am interested to submit a paper (or more) to your journal... I would like to ask about the average

period from date of submission to date of publication (if the paper is accepted)... and also about the fees (if any). Thank you..

Achmad Herman

reply



Elena Corera 3 years ago

SCImago Team

Dear Achmad, we suggest you locate the author's instructions on the journal's website.
Best Regards, SCImago Team

N Nahed 3 years ago

Hello,

Is it possible to know if this Journal is indexed in Thomson Reuters (M)?

Best

reply



Elena Corera 3 years ago

SCImago Team

Dear Insum, we suggest you contact the journal directly. Best Regards, SCImago Team

H Hashim 3 years ago

Dear Sir or Madham

Could you please give me the impact factor for this journal ?

best regards

reply

M Maria Helena Andrade Santana 3 years ago

Dear Sir or Madham

Could you please give me the impact factor for this journal ?

best regards



Elena Corera 3 years ago

SCImago Team

Dear Maria Helena, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our page to locate the journal. We suggest you consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team



Elena Corera 3 years ago

Dear Hashim, the SJR data of the journal are on this page, see the evolution graphs of the indicators above. Best Regards, SCImago Team

M Mikle 3 years ago

Hello,
Does this journal has or will have an impact factor?
Thank you in advance

reply



Elena Corera 3 years ago

Dear Mikle, SJR uses Scopus data, our impact indicator is the SJR. Check our page to locate the journal. We suggest you consult the Journal Citation Report for other indicators with a Web of Science data source. Best Regards, SCImago Team

J Jad 3 years ago

Hello,

The is possibility to send me a topic of your journal.

Best Regard
Jad Tahouri

reply



Elena Corera 3 years ago

Dear Jad, we suggest you contact the journal directly. Best Regards, SCImago Team

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The users of Scimago Journal & Country Rank have the possibility to dialogue through comments linked to a specific journal. The purpose is to have a forum in which general doubts about the processes of publication in the journal, experiences and other issues derived from the publication of papers are resolved. For topics on particular articles, maintain the dialogue through the usual channels with your editor.

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Source details

Heliyon

Open Access ⓘ

Scopus coverage years: from 2015 to Present

Publisher: Elsevier

E-ISSN: 2405-8440

Subject area: Multidisciplinary

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CiteScore 2020

2.1 ⓘ

SJR 2020

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SNIP 2020

1.079 ⓘ

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$$2.1 = \frac{11.427 \text{ Citations 2017 - 2020}}{5.410 \text{ Documents 2017 - 2020}}$$

Calculated on 05 May, 2021

CiteScoreTracker 2021 ⓘ

$$2.9 = \frac{19.013 \text{ Citations to date}}{6.590 \text{ Documents to date}}$$

Last updated on 04 July, 2021 • Updated monthly

CiteScore rank 2020 ⓘ

Category	Rank	Percentile
Multidisciplinary	#27/110	75th

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Heliyon editors

Heliyon is actively building individual sections that are managed by respected researchers and experts in the field. These dedicated and experienced section editors and their teams of associate editors, supported by our in-house editorial team, are responsible for managing the peer review process for all submitted manuscripts within their subject sections. These dedicated sections allow us to tailor each author's experience to the needs and standards they have come to expect within their respective fields.

Agriculture

Meet the full editorial team for *Heliyon Agriculture*.



Dr. Athanasios Damialis

Dr. Athanasios Damialis is a multi-disciplinary scientist working for more than 20 years on the fields of plant and fungal ecology, environmental sciences, biometeorology, climate change and environmental health. His particular focus lies on the reproductive biology of plants (flowering phenology, atmospheric circulation of airborne pollen) and on endophytic fungi. He uses an inter-disciplinary research approach with environment-environment interactions and human-environment interactions. This includes mainly those interactions including, but not limited to, the detection of bio-climatic indicators and spatiotemporal patterns of plant, forest and agricultural habitats and ecosystems, in relation to ongoing and simulated climate change. His research goal is to comprehend the responsive ability of organisms under stress conditions, ultimately, attempting to promote sustainable growth and environmental quality.

Arts and humanities

Meet the editorial team for *Heliyon Arts and humanities*.

Biochemistry, molecular biology and cell biology

Meet the full editorial team for *Heliyon Biochemistry, molecular biology and cell biology*.



Prof. Nicola Zambrano

Nicola Zambrano is professor of Molecular Biology at the University of Naples Federico II, and group leader at CEINGE Advanced Biotechnologies, Naples, Italy. He holds a M.Sc. degree in biological sciences and a Ph.D. in biotechnologies, acquired within a joint doctoral program from the Universities of L'Aquila and Naples, Italy. He was a visiting fellow at National Cancer Institute, NIH in Bethesda from 1991 to 1994, and visiting scientist at EMBL in Heidelberg, Germany in 1997. His academic career at the Federico II University in Naples started with an assistant professor position in biochemistry (1996), before being enrolled as an associate professor (2002) and then, as a full professor in molecular biology (2010).



Prof. Jinrong Min

Professor Jinrong Min received his Ph.D. degree in physics from the Institute of Physics, Chinese Academy of Sciences in China, and carried out his post-doctoral training in chromatin structural biology at the Cold Spring Harbor Laboratory, USA. He is currently the principal investigator of the Chromatin Structural Biology Group at the Structural Genomics Consortium (SGC), University of Toronto, and an associate professor in the Department of Physiology at the University of Toronto.

Biology

Meet the editorial team for *Heliyon Biology*.

Business and economics

Meet the full editorial team for *Heliyon Business and economics*.



Dr. Larisa Yarovaya

Professor Larisa Yarovaya received her doctorate in finance from Northumbria University in England. Currently, she is a lecturer in finance, Programme Director BSc Finance, and deputy head of Centre for Digital Finance at the Southampton Business School, University of Southampton.

Prof. Yarovaya is a researcher the fields of international finance, digital finance, financial integration, Islamic finance, energy economics, information transmission, and international business. She has published her research in peer-reviewed academic journals and is an associate editor of the *International Review of Financial Analysis*, *Journal of International Financial Markets Institutions and Money*, *Heliyon*, and *Data-in-Brief*.



Dr. Pavlos Delias

Pavlos Delias is a tenured faculty member at the International Hellenic University, Department of Accounting and Finance. He holds a jointly supervised PhD from both Technical University of Crete and University Paris Dauphine, under a cotutelle agreement.

Pavlos Delias has been invited as a visiting professor in several universities (national as well as international). He has contributed to numerous research projects, focusing on applying the principles of business analytics and operational research to decision support systems design and use. He is also a member of the coordination board for the EURO working group on decision support systems. His research interests are in the areas of business process analytics, business analytics and operational research, and multiple criteria analysis.

Chemistry

Meet the full editorial team for *Heliyon Chemistry*.



Dr. Francesco Epifano

Prof. Epifano obtained his degree in medicinal chemistry and pharmaceutical technology in 1993 from the University of Perugia, Italy. In 1998, he obtained his Ph.D. in agricultural entomology at the Faculty of Agricultural Sciences of the University of Perugia. Currently, he is an associate professor of medicinal chemistry at the Department of Pharmacy of the University Gabriele D'Annunzio of Chieti-Pescara. His recent work is concerned with synthesis and pharmacological properties of secondary metabolites from plants, fungi, and bacteria. Dr. Epifano was the recipient of the 2010 IADR / Glaxo Smith Kline Innovation in Oral Care Award as the co-investigator of the project entitled "Therapeutic potential of Citrus auraptene for periodontal disease", the 2012 Apivita Award for Phytochemistry, and the 2017 Pierre Fabre – Phytochemical Society of Europe Innovation Award.

Clinical research

Meet the full editorial team for *Heliyon Clinical research*.



Dr. Carolyn Mackintosh-Franklin

Dr. Carolyn Mackintosh-Franklin has had an extensive career in both clinical practice and higher education working at the University of Bradford, University of Liverpool, University of Hull and currently working at the University of Manchester. She received her first degree from the University of Newcastle Upon Tyne, her MSc from the University of Manchester and doctorate from the University of Bradford. She is also a registered nurse specializing in the assessment and management of acute and chronic pain. Her research interests are broad ranging; encompassing work on health care professionals' attitudes towards those in pain, aspects of pain assessment and management, and pedagogic research into learning needs of mature students, with a range of highly cited publications and conference presentations in these areas.



Prof. Giuseppe Musumeci

Giuseppe Musumeci received a BS, MS and PhD in Human Movement and Sport Sciences from the University of Catania, Italy. Currently, he works as a Professor of Sports Sciences at the Department of Biomedical and Biotechnological Sciences, School of Medicine, University of Catania, Italy. He is also an Adjunct Professor at the Temple University's College of Science and Technology, Philadelphia, USA and at the Faculty of Sport Sciences, Fujian Normal University, Fuzhou, China. Prof. Musumeci is the Director of the Research Center on Motor Activities (CRAM), the Director of School of Posturology and Physical Exercise Sciences, the Dean of the Human Movement Sciences Faculty and the Head of the Movement Innovation PosturalLab at the University of Catania. He is currently Editor-in-Chief of "Journal of Functional Morphology and Kinesiology". Musumeci's research interests are centered on morphological, molecular, biochemical and clinical aspects of osteoarthritis and musculoskeletal disorders and the relative effects of diet, ageing and physical activity. Other research topics of interest are tissue engineering and mechanobiology related to the musculoskeletal system in the clinical context.



Prof. Graham Pawelec

Graham Pawelec received an MA in natural sciences and a PhD in transplantation immunology from the University of Cambridge, UK. He is currently professor of experimental immunology in the Department of Immunology, University of Tübingen, Tübingen, Germany. He is a visiting professor at Nottingham Trent University, UK and at King's College London, UK, holds an honorary chair at Manchester University, UK. He is a member of the Cancer Solutions Program at the Health Sciences North Research Institute of Canada, Sudbury, Ontario, Canada. He is currently co-editor-in-chief of "Immunity and Aging". Graham's research interests are centred on alterations to immunity, especially T cell-mediated immunity, in ageing and cancer in man, and the influence these have on the outcome of vaccination and immunomodulatory antibody therapies. The impact of polypathogenicity (including multiple infections, cancer, Alzheimer's, diabetes, autoimmunity) as well as stress (psychological, nutritional) on immune signatures reflecting individual immune status is of particular interest in the clinical context.

Computer science

Meet the full editorial team for [Heliyon Computer science](#).



Dr. Jonathan Chan

Dr. Jonathan H. Chan is an associate professor of computer science and a co-founder of D-Lab at the School of Information Technology, King Mongkut's University of Technology Thonburi, Thailand. Jonathan holds a Ph.D. from the University of Toronto, where he has also served as a visiting professor. In addition to his role as the section editor of *Heliyon Computer science*, Dr. Chan is an action editor of *Neural Networks*, and a member of the editorial boards of *International Journal of Machine Intelligence and Sensory Signal Processing*, *International Journal of Swarm Intelligence*, and *Proceedings in Adaptation, Learning and Optimization*.

Dr. Chan is a founding member and a current VP of the IEEE-CIS Thailand Chapter, and a senior member of IEEE, ACM, and INNS, a member of the Professional Engineers of Ontario (PEO), and a governing board member of APNNS. He also holds an NVIDIA Deep Learning Institute (DLI) University Ambassadorship and is a certified DLI instructor. His research interests include intelligent systems, biomedical informatics, and data science and machine learning in general.

Earth science

Meet the full editorial team for [Heliyon Earth science](#).



Prof. Andrew S. Hursthouse

Professor Hursthouse is a professor of environmental geochemistry at the University of the West of Scotland (UWS) and holds a Ph.D. in environmental radioactivity from University of Glasgow and a B.Sc. degree in geochemistry from University of Reading. He holds a 100 talent high-end expert fellowship at Hunan University of Science & Technology, Xiangtan, PRC. He has editorial roles in several earth and environmental science journals and has worked in academic and industrial research environments.

Professor Hursthouse's areas of interest and expertise are in earth process interactions and the environmental geochemistry of metallic elements, resource exploitation and implications for human health, and this approach also applied to environmental pollution, industrial processes, economic development and society; remediation and treatment of chemical pollution; chemical and environmental hazards, waste and environmental management and regulation.

Education

Meet the full editorial team for [Heliyon Education](#).



Prof. David González-Gómez

Heliyon Education is led by Section Editor David González-Gómez, Ph.D. Dr. González-Gómez is a Professor in the Department of Science and Mathematics Education and the Dean of the Teaching Trainer School at the University of Extremadura (Spain). Dr. González-Gómez is known internationally for work in science education; science, technology, engineering, and mathematics (STEM); active learning methodologies for teaching science; affective domain in the science learning process; education for the sustainability; SDGs. Currently, he is an advisory council of the Science, Technology, and Innovation of Extremadura government in Spain.

Energy

Meet the full editorial team for *Heliyon Energy*.



Dr. Socrates Kaplanis

Prof. Socrates Kaplanis obtained his degree in physics from University Thessaloniki, a MSc in nuclear reactors from Aston University, and a PhD in radiation detection and modelling from the University Patra. He has held academic positions including professor of renewable energy systems at the Technological Educational Institute of Patra, head of the renewable energy systems laboratory, honorary professor and doctor honoris causa at the Transylvania University in Brasov, and as a visiting professor at the University of Applied Sciences in Aachen, Germany.

Prof. Kaplanis has a research background in solar radiation, prediction modelling, zero and intelligent energy buildings, PV systems engineering, solar thermal engineering, and PV based hybrid systems. He has held various posts, including president of the Technological Educational Institute of Patra, president of the Technological Educational Institute of Western Greece, and vice-president and President of the European Institutions in Higher Education (EURASHE).

Engineering

Meet the full editorial team for *Heliyon Engineering*.



Dr. Andrea Francesco Morabito

Professor Andrea Francesco Morabito received his Ph.D. in computer, biomedical, and telecommunications engineering from the University of Reggio Calabria, Italy, where he has also served as an assistant professor in electromagnetic fields since 2010. His research work is mainly focused on models and effective strategies for the solution of inverse problems, in particular, antenna synthesis, phase retrieval, and electromagnetic inverse scattering.



Prof. Mohammad Mehdi Rashidi

Professor Mohammad Mehdi Rashidi received his Ph.D. in mechanical engineering from Tarbiat Modares University, Iran. He is currently a professor of mechanical engineering at Tongji University in Shanghai, China, and previously taught at Bu-Ali University in Iran. Prof. Rashidi was named a 2018 highly cited researcher by Clarivate Analytics.

Environment

Meet the full editorial team for *Heliyon Environment*.



Prof. Frederic Coulon

Professor Frederic Coulon holds a chair in Environmental Chemistry & Microbiology at Cranfield University, UK. In addition to his position as section editor for *Heliyon Environment*, Prof. Coulon is an associate editor for *Environment International* and *Science of the Total Environment*. His professional interests include: soil and water chemistry; fate and transport of chemicals in surface and subsurface waters; water and wastewater treatment; soil and sediment treatment; hazardous waste site remediation; energy and environment; population and environment; and public communication of environmental science and engineering. His research achievements address international priorities under the umbrella of the Water-Soil-Waste nexus across sectors and scales. His work is premised on the understanding that environmental resources are inextricably intertwined and therefore there is a need of advancing a nexus approach to enable integrated and sustainable management of water, soil and waste systems.



Prof. Christian Sonne

Professor Christian Sonne, DVM, PhD, DScVetMed, Dipl. ECZM-EBVS, holds a professorship in veterinary ecotoxicology and wildlife medicine at Aarhus University, Denmark. In addition to his position as section editor for *Heliyon Environment*, Prof. Sonne serves as special issues editor for *Environmental Pollution*. Since 1997, Prof. Sonne has specialized in the cross-field of biological effects from exposure to environmental chemicals, diseases and climate change, giving him a unique insight and profile working with a broad range of animals including predatory mammals, raptorial birds, sea birds, fish and humans. He has a broad insight and interest in internal and reproductive organs (histopathology, size, and morphology), skeletal system (bone density and morphology using e.g. DXA scanning), immune system (intra dermal testing of lymphocyte functioning, immune globulin production and cytokine and APP expressions), endocrine system (steroid and peptide hormones), PBPK modelling, blood biochemistry and infectious diseases (zoonosis). Prof. Sonne uses his global network to obtain interdisciplinary research results. Since 2015, he has applied his in-depth knowledge and understanding of biological processes to also include specific un-solved wildlife issues in Denmark (eider duck population declines) and health of raptors. Recently his innovative approaches have led to the first interactions with private industry focusing on natural resources developments and translational medicine within insulation, osteoporosis and metabolic syndrome. Prof. Sonne also specializes in surgical field implantations of intra-coelomic (abdominally) and subcutaneously satellite transmitters (PTTs) in various sea bird species and immobilization of deer spp.

Food science and nutrition

Meet the full editorial team for *Heliyon Food science and nutrition*.



Prof. Lilian Mariutti

Prof. Lilian R. B. Mariutti received her master and doctorate degrees in food science from the School of Food Engineering - University of Campinas, Brazil, where she currently has a position as assistant professor. She was a researcher fellow in the Laboratory of Veterinary Drug Residues of the Brazilian Ministry of Agriculture, Livestock and Food Supply. Her research focuses on the identification and bioaccessibility of bioactive compounds and lipids and design of food ingredients from non-conventional sources.

Global Health & Infectious Disease

Meet the full editorial team for *Heliyon Global Health & Infectious Disease*.



Dr. Chaisiri Angkurawaranon
Public Health
Chiang Mai University, Chiang Mai, Thailand

Chaisiri Angkurawaranon received his MD from Chiang Mai University and specialises in Family Medicine. He received a Masters in Medical Statistics and a PhD in Non-communicable Disease Epidemiology from the London School of Hygiene and Tropical Medicine. His research focuses on global health issues related to ageing and chronic conditions (both communicable and non-communicable) in primary care.



Dr. Nitika Pant Pai
Infectious Disease
McGill University, Montreal, Canada

Dr. Nitika Pant Pai is a tenured Associate Professor in the Department of Medicine at McGill University. Her global implementation research program for the past twenty years is focused on point-of-care diagnostics for HIV and other sexually transmitted blood borne infections; specifically the innovation, implementation and impact of digital strategies with rapid diagnostics and wearable solution. She develops integrated connected strategies with digital innovations, Bayesian diagnostics, artificial intelligence to plug health service delivery gaps in diagnostics in rapid diagnostics. She serves to inform domestic and global policy on point-of-care diagnostics.

Her research program is based in Canada, India and South Africa. She has led many diagnostic trials, cohort/cross sectional studies, meta-analyses, systematic reviews, modelling studies, to inform the gaps in policies to end the HIV epidemic. Her research has been supported by grants from the Canadian Institutes of Health Research, the FRQS, Grand Challenges Canada, Bill and Melinda Gates Foundation, National Institutes of Health, MRC SHIP, South African DST, IC-IMPACTS, Clinton Health Access Initiative, among others.

She has served on many technical working groups for national and international agencies: WHO, Foundation for Innovative Diagnostics, PSI, The Bill and Melinda Gates Foundation, ASLM, CDC, PHAC, REACH, among others. She has advised the office of the US Congress on multiplex testing. She has also contributed to HIV self-testing guidelines and policy guidance for HIV self-testing for the WHO. She serves the Strategic Advisory Board of the Foundation for Innovative Diagnostics and is on WHO's Roster of Digital Health Experts. She serves on the Editorial Board for biomedical journals and regularly reviews for key international health agencies.

She is an elected member of the College of New Scholars, Artists & Scientists of the Royal Society of Canada.

Materials science

Meet the full editorial team for *Heliyon Materials science*.



Prof. Luis M. Gandía

Luis M. Gandía is a full professor of chemical engineering at the Public University of Navarre (UPNA) since 2010. Prof. Gandía obtained his Ph.D. in chemistry at the Faculty of Chemistry of the University of the Basque Country in Donostia/San Sebastián in 1993. He is a founding member of the Institute for Advanced Materials (InaMat) at UPNA. He is the head of a multi-disciplinary research team mainly working on renewable resources valorization and the development of catalytic materials for environmental and energy applications. His research interests include: preparation and physico-chemical characterization of heterogeneous catalysts: structured and micro-structured catalysts and chemical reactors:

Mathematics

Meet the full editorial team for [Heliyon Mathematics](#).



Prof. Hermann J. Eberl

Dr. Hermann Eberl is a professor in the Department of Mathematics and Statistics at the University of Guelph (Canada), where he is also the director of the Biophysics Interdepartmental Graduate Program. Prior to joining the University of Guelph he obtained his graduate degrees (Dipl.Math., Dr.rer.nat) at the Technical University of Munich (Germany) and was a postdoctoral fellow first at the Delft University of Technology (the Netherlands), and then at the GSF National Research Center for Environment and Health in Oberschleissheim (Germany).

His research is in mathematical modelling, analysis, and simulation of biological systems and their interaction with their physical environment. This encompasses dynamical systems, partial differential equations, numerical analysis and scientific computing. The two primary strands of his research in recent years were the development and application of mathematical methods in biofilm research and mathematical modelling of honeybee colonies and their diseases.

Microbiology

Meet the full editorial team for [Heliyon Microbiology](#).



Dr. Dana Stanley

Associate Professor Dana Stanley was awarded a PhD in molecular microbiology from Victoria University, Melbourne, in 2009. Her PhD project, "Generation and Characterisation of Ethanol-Tolerant *Saccharomyces cerevisiae* Mutants," investigated the molecular and metabolic determinants of ethanol tolerance in yeast and was awarded "the most outstanding PhD in 2009" by the University. Prof. Stanley held a postdoctoral position in CSIRO's Animal Health Laboratories (AAHL), one of the world's most sophisticated animal research laboratories, where she researched poultry intestinal health, specifically gut microbiota and genetics. Currently, Prof. Stanley is a leader of the molecular microbiology research cluster at Central Queensland University, focusing in human and livestock intestinal health, probiotic and next generation antibiotic development and pathogen control. She is working in collaboration with world's leading probiotic companies on research projects aiming to improve intestinal health of agricultural animals and humans. Prof. Stanley's work has been published in *Nature Medicine* (as the first author), *Nature Communications* and *Nature Immunology*.

Neuroscience

Meet the full editorial team for [Heliyon Neuroscience](#).



Dr. Mario Tiberi

Dr. Mario Tiberi is a senior scientist at the Ottawa Hospital Research Institute's Neuroscience Program, and associate professor at the University of Ottawa Faculty of Medicine in the departments of medicine, cellular and molecular medicine, and psychiatry. He is also a member of the University of Ottawa Brain and Mind Research Institute. Dr. Tiberi completed his PhD in Pharmacology (1990) on opioid receptors at the Université de Montréal under the supervision of Dr. Jacques Magnan, before moving on to a very successful post-doctoral training at the Howard Hughes Medical Institutes at Duke University in Dr. Marc Caron's laboratory. It was during his postdoctoral training that Dr. Tiberi refined his area of research expertise in molecular biology and biochemistry of dopamine receptors. His research interests focus on dopamine receptors, G proteins, signal transduction, desensitization and phosphorylation. Dr. Tiberi's work aims to understand complex structure and molecular relationships of dopamine receptor signaling complexes using in vitro cellular systems and pre-clinical in vivo models, with the aim of aiding in the development of novel therapeutic strategies for brain disorders such as Parkinson's disease, stroke, schizophrenia and drug addiction. Dr. Tiberi has published over 50 scientific papers and edited two books. He has wide experience with undergrad and graduate student supervision as well as teaching. Many of his former graduate students have gone on to successful independent research careers.

Pharmaceutical science, pharmacology and toxicology

Meet the full editorial team for *Heliyon Pharmaceutical science, pharmacology and toxicology*.



Prof. Emilio Clementi

Emilio Clementi graduated in medicine and surgery at the University of Milano, received his doctorate in pharmacotherapy at the University of Brescia to move as research fellow to the University College London. He is currently full professor of pharmacology and director of the clinical pharmacology unit of the National Health System at the University of Milano, co-opted member in the executive committee of the International Union of basic and clinical Pharmacology (IUPHAR).

He has published on the pathophysiology of nitric oxide and its relevance in therapeutic perspective, especially in skeletal muscle, and on pharmacokinetics, pharmacogenetics and pharmacoepidemiology in paediatrics. He is presently the editor in chief of pharmacological research.



Dr. Dimitrios Lamprou

Dimitrios Lamprou (Ph.D. MBA) is a reader in pharmaceutical engineering and the MSc programme director in industrial pharmaceuticals at the School of Pharmacy in Queen's University Belfast (UK). He is also the chair at United Kingdom and Ireland Controlled Release Society (UKICRS). Dr. Lamprou specialises in the areas of pharmaceutical manufacturing & emerging technologies and his research and academic leadership have been recognised in a range of awards, including the Royal Pharmaceutical Society Science Award and the Scottish Universities Life Sciences Alliance Leaders Scheme Award. His group is applying nano and microfabrication techniques in pharmaceutical and medical device manufacturing, such as 3D printing & bioprinting, electrospinning and microfluidics.



Dr. Martin Leonard

Dr. Leonard obtained his PhD in pharmacology in 2000 from University College Dublin, Ireland. He has over 15 years' experience as a toxicologist focussed to developing and improving on models and methods for assessment of toxicological hazard, including the use of high content omics technology and iPSC in vitro models of the airway. Dr. Leonard is a European registered toxicologist and currently holds a position as principal toxicologist at Public Health England directing research into the mechanisms of allergen and particulate hazard associated with asthma and allergic airway disease. Dr. Leonard has published extensively in the fields of toxicology, cell biology and immunology. In addition to section editor at *Heliyon*, he is also associate editor for the journal *Toxicology in Vitro*.

Physics

Meet the full editorial team for *Heliyon Physics*.



Prof. Gerald Cleaver

Gerald B. Cleaver earned his Ph.D. in early universe cosmology and string theory at Caltech. He is a professor and graduate program director of the department of physics at Baylor University in Waco, Texas. He also heads the Early Universe Cosmology and String Theory (EUCOS) division of Baylor's Center for Astrophysics, Space Physics and Engineering Research (CASPER).

With CASPER colleagues, Prof. Cleaver (i) explores quantum gravity effects in the early universe and the signatures of specific quantum gravity proposals, especially with regard to the cosmic microwave background (CMB), (ii) studies relativistic thermodynamics and physics & cosmology applications to cryptography, (iii) analyzes spacetime curvatures (and their possible divergences) for theorized spacetime wormholes, and (iv) investigates advanced spacecraft propulsion systems. Prof. Cleaver was a member of a NASA blue-ribbon review committee for advanced propulsion system proposals. He has written over 100 journal articles and conference proceedings, is co-author of an elementary particle physics textbook, author of six book chapters, on the editorial board of four science journals, and referee for nine physics journals.

Psychology

Meet the full editorial team for *Heliyon Psychology*.



Dr. Pavica Sheldon

Dr. Pavica Sheldon received her PhD in communication studies from Louisiana State University, and currently serves as chair and associate professor in the Department of Communication Arts at University of Alabama in Huntsville. Dr. Sheldon is an author of three books and over 40 journal articles, studying uses and gratifications of social media, and also how people communicate forgiveness in interpersonal relationships.

Quantitative biology, biotechnology and bioengineering

Meet the full editorial team for *Heliyon quantitative biology, biotechnology and bioengineering*.



Dr. Andrea de Martino

Andrea De Martino received his PhD in theoretical physics from SISSA (Trieste, Italy). He worked at the Hahn-Meitner-Institut (Berlin, Germany), the Italian Institute for the Physics of Matter (Rome, Italy) and Sapienza University (Rome) before joining the National Research Council and, more recently, the Italian Institute for Genomic Medicine in Turin, where he is part of the Statistical Inference & Computational Biology Unit.

Dr. De Martino is generally interested in the physics of living systems across multiple scales, from single cells to ecosystems. He works in broadly defined systems biology (computational & mathematical biology, genome-scale models, bioinformatics, etc.). Dr. De Martino's favorite questions revolve around the functional roles of cell-to-cell heterogeneities, the interplay between physiology and gene expression in proliferating vs quiescent cells, the processing of information by biological networks, and the emergence of multi-cellular and population-level behavior.

Social science

Meet the full editorial team for *Heliyon Social science*.



Prof. P. Vigneswara Ilavarasan

P. Vigneswara Ilavarasan (PhD - IIT Kanpur) is a professor of information systems at the Dept. of Management Studies, Indian Institute of Technology Delhi. He researches and teaches about the interaction of information and communication technologies (ICTs), society, and business.

Dr. Ilavarasan has been a visiting research fellow at United Nations University - School of Computing and Society (Macau) and School of Management, Curtin University (Perth). He is a recipient of the Outstanding Young Faculty Fellowship Award at IIT Delhi and Prof. M.N. Srinivas Memorial Prize of the Indian Sociological Society. He is also a senior research fellow at LIRNEasia, a leading regional ICT policy and regulation think tank. He has received large research grants from Dept of Science & Technology (Govt of India), ICSSR (India), IDRC (Canada), Oxford Analytica (UK), IPTS (European Commission), CIPPEC (Argentina) and IdeaCorp (Philippines). His research has appeared in various leading international journals and at numerous global conferences.




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 Research article ● Open access**Magnetotelluric data analysis using 2D inversion: A case study from Al-Mubazzarah Geothermal Area (AMGA), Al-Ain, United Arab Emirates**

Hakim Saibi, Sadieh Khosravi, Biruk Abera Cherkose, Maxim Smirnov, ... Abdel-Rahman Fowler

Article e07440


[Download PDF](#)[Article preview](#) **Abstract****Abstract**

Geothermal manifestations (hot springs) emerge in the Al-Mubazzarah Geothermal Area (AMGA), Al-Ain city, Abu Dhabi Emirate, United Arab Emirates. This paper presents the application and results of a Magnetotelluric (MT) survey, which was carried out in 2017 at the AMGA geothermal field. The MT method was used to investigate the variations in the electrical conductivity beneath the AMGA. This study focuses on characterizing the patterns of subsurface electrical conductivity of the AMGA geothermal reservoir. Dimensionality analysis of the measured MT data indicate that 2D inversion is appropriate for the subsurface resistivity interpretation. The inversion results support a model consisting of three resistivity-defined layers; from top to bottom they are: (1) a shallow layer with resistivity ranging from 10 to 20 Ωm , representing recent alluvial and windblown deposits, (2) a second conductive layer with resistivities less than 10 Ωm , beneath the first layer. This layer is recognized as the Tertiary carbonate sequence in the region. (3) a deep, moderate to relatively high resistive zone, 10–30 Ωm beginning at 800 m depth and reaching 4

 Research article ● Open access**Equilibria, stability and chaos in photogravitational Bi-Circular restricted four-body problem**

Jagadish Singh, Solomon Okpanachi Omale

Article e07364

[Download PDF](#)[Article preview](#) **Abstract****Abstract**

A model to investigate the influence of gravitational force and radiation pressure on interstellar dust found within the vicinities of certain stellar systems is presented in this study with the inclusion of potential due to the belt. Semi-analytic approach is adopted to examine the dynamical behaviour of the motion of a test particle in the neighbourhood of the radiating stars, namely, Wolf 630, Formalhaut, Omicron Eridani and 36 Ophiuchi respectively. The Libration points were found dependent on the mass ratios of the systems and the radiation pressure exerted by the star(s) and the motion of the dust particle around them is linearly unstable. In each of the four case studies, two Lyapunov Characteristic Exponents were seen positive which validate the chaotic nature of the system, also the Poincare Surface Section revealed the sensitivity of the dynamical system to change in initial conditions. Several scientific questions of great importance in astrophysics and astronomy; such as the motions of interstellar clouds, proto-nebulae, planetary rings and micrometeorites can be answered by engaging this model.



Research article • Open access

Antibiotic stewardship knowledge and belief differences among healthcare professionals in hospitals: A survey study

Fauna Herawati, Abdul Kadir Jaelani, Heru Wijono, Abdul Rahem, ... Diantha Soemantri

Article e07377

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Abstract

Abstract

Background

Collaborative practice in healthcare has been recommended to improve the quality of antimicrobial stewardship interventions, a behavioral change in antimicrobial use. Insufficient knowledge regarding antibiotic resistance, the fear of complications from infections, and how providers perceive antibiotic use and resistance are likely to influence prescribing behavior. This study's objective was to identify the knowledge and belief healthcare professionals' differences about antibiotic stewardship.

Methods

This cross-sectional survey study of three hospitals in the East Java province, Indonesia utilized a 43-item questionnaire to assess



Research article • Open access

Effect of tillage, biochar, poultry manure and NPK 15-15-15 fertilizer, and their mixture on soil properties, growth and carrot (*Daucus carota* L.) yield under tropical conditions

Taiwo Michael Agbede

Article e07391

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Abstract

Abstract

Tillage, biochar, poultry manure, NPK fertilizer and their combined application could improve soil quality, sustainability and carrot productivity. The effects of two tillage treatments: conventional tillage (CT) and reduced tillage (RT) each combined with 30 Mg ha⁻¹ biochar (B), 10 Mg ha⁻¹ poultry manure (PM), 300 kg ha⁻¹ NPK 15-15-15 fertilizer, 150 kg ha⁻¹ NPK 15-15-15 fertilizer +15 Mg ha⁻¹ biochar +5 Mg ha⁻¹ poultry manure and a control (no biochar/poultry manure/NPK fertilizer) on soil properties, growth and carrot yield were investigated. The research was carried out for two consecutive growing seasons (2018 and 2019) at Owo in the forest-savanna transition zone of Nigeria on a sandy loam. The experiment was laid out in a randomized complete block design in a factorial combination of ten treatments and replicated three times. Reduced tillage had relatively lower soil bulk density, penetration resistance, dispersion ratio and temperature, and had significantly higher ($p = 0.05$) soil aggregate stability, mean weight diameter, porosity and water content than conventional tillage and these resulted in higher soil pH, organic C, N