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Research Article

Measuring the True Dissemination of Gastroenterology and Hepatology Research- An Alternative Metrics Analysis of Most Influential Research Articles

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Abstract

Background and Study Aims: Bibliometric analysis has long been established as a marker of scientific research quality; however, it fails to measure the impact of research on the non-scientific population and the dissemination of knowledge from research to clinical practice. These short comings have recently been addressed by alternative metrics. We aim to: (i) determine the most influential Gastroenterology and Hepatology (G&H) journal articles using alternative metrics; (ii) identify the factors influencing alternative metrics; and (iii) analyse the relationship between alternative metrics and bibliometrics.

Patients and Methods: Altmetric.com search tool was used to determine the 100 most influential G&H articles based on their Altmetric Attention Scores (AAS). Bibliometric analysis of these articles was then carried out and the online media factors that influence AAS were also recorded.

Results: The AAS of the top 100 mentioned articles ranged from 2123 to 48. Nature Reviews Gastroenterology and Hepatology (48) and Lancet Gastroenterology and Hepatology (28) were the most prolific journals with USA (35) and England (19) having the most publications. Inflammatory Bowel Disease, Gut microbiome/microbiota and Hepatitis C were the most influential topics. Twitter mentions, Mendeley readers, news mentions, and Facebook mentions all showed positive association with AAS. There was no significant correlation between AAS and bibliometrics.

Conclusion: The dissemination of G&H research is multifarious across countries, journals and topics of research. Online media is an essential tool for researchers and publishers for rapid dissemination of newly created knowledge. Alternative metrics in combination with bibliometrics provide an in-depth measure of the research dissemination.

Keywords: *Altmetrics; Alternative Metrics; Bibliometrics; Social Media; Scholarly Impact; Web; Gastroenterology; Hepatology; Citation Metrics; Impact Factor*

Introduction

Journal Impact factor (JIF) and citations analysis has long been established as a measure of the quality of scientific research [1-3]. JIF is synonymous with the reputation of the journal and brings a degree of prestige to it [4]. It is calculated as the average number of citations the citable articles have gained in the current year which were published in the journal in previous two years. JIF is an excellent tool to measure the quality of journals, however there are limitations on its use in assessing the quality of individual articles [2]. Citation analysis on the contrary can be used to compare individual articles' value and also provide a measurement of the dissemination of knowledge cre-

ated by these articles [2]. However, citations analysis has its own limitations. It is time dependent and generally takes years for articles to gain citations [5]. There is also criticism with the practise of self-citations by researchers. Also, since it only measures dissemination of knowledge in the scientific community, it does not provide the true dissemination of knowledge created by publications [6]. Additionally, as large proportion of publications are never cited, the use of citation analysis therefore downgrades the importance of these publications in terms of knowledge creation [2,7,8]. Hence, alternative analysis metrics that go beyond JIF and citations analysis are needed to provide a rapid measurement of true dissemination of scientific publications [9-11].

Our behaviour towards conducting and sharing of scientific research have also changed dramatically with the advent of internet. Scientific research have moved from a closed intradisciplinary entity to one that is multidisciplinary and open access [3]. Increasingly, physicians are obtaining scientific knowledge via internet and journals are using their online presence for dissemination purposes [12]. Recently, there has been suggestions that online media can provide a platform for rapid and wider dissemination of scientific research [13]. Alternative metrics which measure article-level metrics based on article's online visibility have been proposed for this purpose [5,6,8,14].

There are alternative metrics toolkits and services such as *Altmetric.com, Plum Analytics, Metrics Toolkit, Mendeley Impact Story, Acumen and Peer Evaluation* which provide metrics about a publication's social impact and attention it receives in online media [15-18]. Altmetric Attention Score (AAS), a proprietary of Almetrics.com has received a lot of attention lately as a tool for measuring alternative metrics (6). AAS is a composite score and is based on three main factors: (i) volume of article mentions; (ii) author's publications and online behaviour; and (iii) weight of online sources such as Twitter, Facebook, news articles, blogs, etc. The AAS is presented visually as a colored "Doughnut". Each color in the donut represents the social media source that contributes to the AAS, which itself is represented at the center of the doughnut [19-21] (Figure 1).

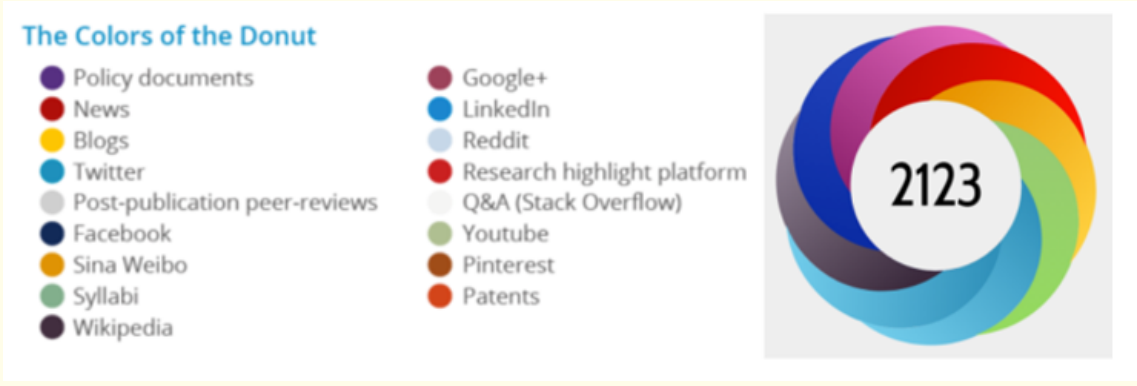


Figure 1: *The Altmetric assessment donut and score. The AAS is presented visually as a coloured "Doughnut". Each colour in the doughnut represents the social media source that contributes to the AAS, which itself is represented at the center of the doughnut.*

Use of Altmetrics to highlight the most influential research articles in other medical disciplines such as neuro- intervention [22], nursing [23], dental [24], etc has been reported. In Gastroenterology, preliminary data in abstract form has shown a positive correlation between twitter exposure and the number of citations for articles published in five major gastroenterology journals [25]. A retrospective analysis of articles published in one gastrointestinal endoscopy journal showed a strong association between article mentions on Twitter and citations rates [26]. A bibliometric analysis of top 100 clinical articles in digestive diseases highlighted the impact of publications on scientific process, however the authors concluded that newer metrics are needed to assess the importance of publications on clinical

practice [27]. To the best of our knowledge, the alternate-metric analysis of the most mentioned articles in the field of Gastroenterology and Hepatology (G&H) has not yet been reported. We aim to therefore (i) determine the 100 most influential Gastroenterology and Hepatology (G&H) journal articles using alternative metrics; (ii) identify the factors influencing alternative metric scores and (iii) analyze the relationship between alternative metrics and traditional metrics.

Materials and Methods

This was a retrospective cross-sectional study evaluating 100 most mentioned G&H articles in social media published in 2016 and 2017. This study did not involve human subjects and thus did not require approval from an institutional review board.

Identification of the 100 most mentioned G&H articles in online media

An 'Advanced search' with "Gastroenterology" "Hepatology" was carried out on the Altmetric Explorer (https://www.altmetric.com/explorer/highlights, Altmetric LLP, London, UK) on 05th March 2020 in one sitting to avoid changes in online media activity of articles. Citations are time-dependent and usually take a long time for articles to gather citations [5]. Therefore, only articles published between January 1st 2016 and 31st December 2017 were selected, to give these articles at least two years from the publication date, to gain citations. This timeframe to gain citations have previously been suggested in a study comparing traditional and alternative dissemination metrics [14].

This search revealed 2,755 articles, which were arranged as per their AAS. Four articles in the top 100 were excluded as they were from the journal *Cellular and Molecular Gastroenterology and Hepatology* (this journal will receive its first JIF in June 2020 and is therefore not listed in JCR database). One article published in the *Journal of Gastroenterology and Hepatology* was excluded as it contained reports from a medical meeting [28]. Another article titled *"Therapeutic Use of Cannabis in Inflammatory Bowel Disease"* [29] could not be found on Web of Sciences database either by title, author, year of publication or DOI and was therefore also excluded. The remaining top 100 articles were then selected for analysis.

To ascertain the relationship between alternative and citation metrics, we also analyzed the top 100 most cited G&H journal articles in 2016 and 2017 using citation analysis. These were assessed from *Web of Science database (Citations in In Web of Science Core)* using the "advanced search" option, on March 05, 2020 via National University of Ireland Galway library. This search revealed 11,720 articles, which were then arranged as per their total citation counts and the top 100 articles were selected for further analysis.

Analysis of articles

We analyzed the full text of the most mentioned and most cited articles. The following information was extracted: topic of the article; ASS; year of publication; authorship; country of origin; journal title; JIF (based on the 2018 science edition of the *Web of Sciences);* type of document (original research, review article, clinical guideline/consensus statement, systematic review/meta-analysis or letter); and the number of citations *(Web of Science database Core Collection).*

Statistical analysis

The median, mean and standard deviation (SD) of AAS, number of citations and Journal Impact factor (JIF) was calculated. The following statistical tests were used: (i) Mood Median Test to evaluate differences in AAS and citations count based on the type of the journal articles; (ii) Two-sample t-test to evaluate the difference between the citations count and AAS in year 2016 and 2017; (iii) Fisher's exact test to determine the variance in (a) topics of research, (b) research type and (c) publication journals between the most mentioned and most cited articles; (iv) Regression analysis to evaluate the correlation between (a) the AAS and online media sources; (b) citations count and online media sources; (c) AAS and citations count; (d) AAS and JIF; and (e) citations count and JIF. The strength of the relationship was

described by the Coefficient of determination (r^2), where values of r^2 >50% indicated a strong correlation. P values were based on two-sample t-test and values < 0.05 were considered significant. All statistical analysis was performed with Minitab version 17.3.1 *(Minitab Inc., PA, USA).*

Supplementary section

Section 1: 100 most mentioned Gastroenterology and Hepatology articles ranked as per Altmetric Attention Score (AAS), obtained from the Altmetric. com database.

Rank	Altmetric Attention Score (AAS)	Journal/Collection Title	Article Title
1	2124	*The Lancet Gastroenterology and Hepatology*	The mesentery: structure, function, and role in disease
2	570	*Clinical Gastroenterology and Hepatology*	Disparities in Absolute Denial of Modern Hepatitis C Therapy by Type of Insurance
3	533	*The Lancet Gastroenterology and Hepatology*	The microbiota-gut-brain axis in obesity
4	532	*The Lancet Gastroenterology and Hepatology*	Ombitasvir, paritaprevir, and ritonavir plus ribavirin in adults with hepatitis C virus genotype 4 infection and cirrhosis (AGATE-I): a multicentre, phase 3, randomised open-label trial
5	518	*Nature Reviews Gastroenterology and Hepatology*	Gut microbiota modulation of chemotherapy efficacy and toxicity
6	503	*Clinical Gastroenterology and Hepatology*	Efficacy of Vedolizumab Induction and Maintenance Therapy in Patients With Ulcerative Colitis, Regardless of Prior Exposure to Tumor Necrosis Factor Antagonists
7	422	*Nature Reviews Gastroenterology and Hepatology*	Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention
8	371	*Nature Reviews Gastroenterology and Hepatology*	Alcohol: taking a population perspective
9	330	*Nature Reviews Gastroenterology and Hepatology*	Expert consensus document: The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics
10	308	*Clinical Gastroenterology and Hepatology*	Short-term and Long-term Efficacy of Psychological Therapies for Irritable Bowel Syndrome: A Systematic Review and Meta-analysis
11	299	*European journal of gastroenterology and hepatology*	Diagnostic accuracy of confocal laser endomicroscopy for the characterization of liver nodules
12	284	*Nature Reviews Gastroenterology and Hepatology*	Diet, microorganisms and their metabolites, and colon cancer
13	267	*Nature Reviews Gastroenterology and Hepatology*	The mucosal immune system: master regulator of bidirectional gut-brain communications
14	230	*Nature Reviews Gastroenterology and Hepatology*	Proton-pump inhibitors: understanding the complications and risks
15	215	*The Lancet Gastroenterology and Hepatology*	Active observation versus interval appendicectomy after successful non-operative treatment of an appendix mass in children (CHINA study): an open-label, randomised controlled trial

16	204	*Expert Review of Gastroenterology and Hepatology*	Hepatorenal syndrome: the clinical impact of vasoactive therapy
17	201	*The Lancet Gastroenterology and Hepatology*	Mercaptopurine versus placebo to prevent recurrence of Crohn's disease after surgical resection (TOPPIC): a multicentre, double-blind, randomised controlled trial
18	199	*Journal of Gastroenterology and Hepatology*	What is gluten?
19	193	*Clinical Gastroenterology and Hepatology*	Suspected Nonceliac Gluten Sensitivity Confirmed in Few Patients After Gluten Challenge in Double-Blind, Placebo-Controlled Trials
20	192	*Nature Reviews Gastroenterology and Hepatology*	Environmental triggers in IBD: a review of progress and evidence
21	183	*Nature Reviews Gastroenterology and Hepatology*	The bowel and beyond: the enteric nervous system in neurological disorders
22	180	*Nature Reviews Gastroenterology and Hepatology*	A clinician's guide to microbiome analysis
23	178	*Nature Reviews Gastroenterology and Hepatology*	Gut microbiome as a clinical tool in gastrointestinal disease management: are we there yet?
24	175	*Nature Reviews Gastroenterology and Hepatology*	The gut microbiota and gastrointestinal surgery
25	175	*The Lancet Gastroenterology and Hepatology*	Ombitasvir, paritaprevir, and ritonavir plus ribavirin for chronic hepatitis C virus genotype 4 infection in Egyptian patients with or without compensated cirrhosis (AGATE-II): a multicentre, phase 3, partly randomised open-label trial
26	164	*The Lancet Gastroenterology and Hepatology*	Epitope-specific immunotherapy targeting CD4-positive T cells in coeliac disease: two randomised, double-blind, placebo-controlled phase 1 studies
27	162	*Clinical Gastroenterology and Hepatology*	Ethnic Variations in Duodenal Villous Atrophy Consistent With Celiac Disease in the United States
28	158	*Clinical Gastroenterology and Hepatology*	Symptoms of Depression and Anxiety Are Independently Associated With Clinical Recurrence of Inflammatory Bowel Disease
29	153	*Nature Reviews Gastroenterology and Hepatology*	Current and emerging therapeutic targets for IBD
30	149	*Nature Reviews Gastroenterology and Hepatology*	IBS and IBD — separate entities or on a spectrum?
31	145	*Nature Reviews Gastroenterology and Hepatology*	NAFLD and diabetes mellitus
32	142	*Nature Reviews Gastroenterology and Hepatology*	Gut microbiota and IBD: causation or correlation?
33	135	*Nature Reviews Gastroenterology and Hepatology*	Gut microbiota — at the intersection of everything?
34	132	*The Lancet Gastroenterology and Hepatology*	Laparoscopic ileocaecal resection versus infliximab for terminal ileitis in Crohn's disease: a randomised controlled, open-label, multicentre trial
35	126	*The Lancet Gastroenterology and Hepatology*	Effects of liraglutide on weight, satiation, and gastric functions in obesity: a randomised, placebo-controlled pilot trial
36	124	*Clinical Gastroenterology and Hepatology*	Noninvasive Detection of Nonalcoholic Steatohepatitis Using Clinical Markers and Circulating Levels of Lipids and Metabolites

37	123	*Clinical Gastroenterology and Hepatology*	Avoidance of Fiber Is Associated With Greater Risk of Crohn's Disease Flare in a 6-Month Period
38	120	*The Lancet Gastroenterology and Hepatology*	Necrotising enterocolitis: better data, still many questions
39	114	*The Lancet Gastroenterology and Hepatology*	Global prevalence and genotype distribution of hepatitis C virus infection in 2015: a modelling study
40	113	*Nature Reviews Gastroenterology and Hepatology*	Understanding the mechanisms of faecal microbiota transplantation
41	111	*Nature Reviews Gastroenterology and Hepatology*	Clonal evolution of colorectal cancer in IBD
42	110	*Clinical Gastroenterology and Hepatology*	Effects of Gluten Intake on Risk of Celiac Disease: A Case-Control Study on a Swedish Birth Cohort
43	110	*Clinical Gastroenterology and Hepatology*	Low Serum Vitamin D During Remission Increases Risk of Clinical Relapse in Patients With Ulcerative Colitis
44	106	*Nature Reviews Gastroenterology and Hepatology*	The gut microbiome and liver cancer: mechanisms and clinical translation
45	101	*The Lancet Gastroenterology and Hepatology*	Country, regional, and global estimates for lactose malabsorption in adults: a systematic review and meta-analysis
46	101	*The Lancet Gastroenterology and Hepatology*	Effect of psychological therapy on disease activity, psychological comorbidity, and quality of life in inflammatory bowel disease: a systematic review and meta-analysis
47	100	*The Lancet Gastroenterology and Hepatology*	A watch-and-wait approach for locally advanced rectal cancer after a clinical complete response following neoadjuvant chemoradiation: a systematic review and meta-analysis
48	99	*Nature Reviews Gastroenterology and Hepatology*	Alcohol, adipose tissue and liver disease: mechanistic links and clinical considerations
49	97	*Nature Reviews Gastroenterology and Hepatology*	Cholangiocarcinoma: current knowledge and future perspectives consensus statement from the European Network for the Study of Cholangiocarcinoma (ENS-CCA)
50	96	*The Lancet Gastroenterology and Hepatology*	The effect of trainee research collaboratives in the UK
51	95	*Nature Reviews Gastroenterology and Hepatology*	Bariatric surgery for obesity and metabolic disorders: state of the art
52	95	*Nature Reviews Gastroenterology and Hepatology*	Perianal fistulizing Crohn's disease: pathogenesis, diagnosis and therapy
53	94	*The Lancet Gastroenterology and Hepatology*	A non-endoscopic device to sample the oesophageal microbiota: a case-control study
54	94	*The Lancet Gastroenterology and Hepatology*	Risk stratification of Barrett's oesophagus using a non-endoscopic sampling method coupled with a biomarker panel: a cohort study
55	92	*Nature Reviews Gastroenterology and Hepatology*	New UK alcohol guidelines and Dry January: enough to give up boozing?
56	91	*Journal of Gastroenterology and Hepatology*	Nutritional, microbiological and psychosocial implications of the low FODMAP diet
57	91	*Nature Reviews Gastroenterology and Hepatology*	Brain-gut-microbiota axis — mood, metabolism and behaviour
58	88	*Nature Reviews Gastroenterology and Hepatology*	The intestinal epithelial barrier: a therapeutic target?

59	86	*Clinical Gastroenterology and Hepatology*	Use of Proton Pump Inhibitors and Risks of Fundic Gland Polyps and Gastric Cancer: Systematic Review and Meta-analysis
60	81	*Nature Reviews Gastroenterology and Hepatology*	Non-conventional features of peripheral serotonin signalling — the gut and beyond
61	81	*PLoS ONE*	The Expenditures for Academic Inpatient Care of Inflammatory Bowel Disease Patients Are Almost Double Compared with Average Academic Gastroenterology and Hepatology Cases and Not Fully Recovered by Diagnosis-Related Group (DRG) Proceeds
62	77	*Nature Reviews Gastroenterology and Hepatology*	Breakthroughs in the treatment and prevention of Clostridium difficile infection
63	75	*Journal of Gastroenterology and Hepatology*	FODMAPs: food composition, defining cutoff values and international application
64	74	*The Lancet Gastroenterology and Hepatology*	Clinical effects of antivirals for hepatitis C: context is critical
65	73	*The Lancet Gastroenterology and Hepatology*	Hepatitis C virus prevalence and level of intervention required to achieve the WHO targets for elimination in the European Union by 2030: a modelling study
66	71	*The Lancet Gastroenterology and Hepatology*	Seladelpar (MBX-8025), a selective PPAR-? agonist, in patients with primary biliary cholangitis with an inadequate response to ursodeoxycholic acid: a double-blind, randomised, placebo-controlled, phase 2, proof-of-concept study
67	70	*Clinical Gastroenterology and Hepatology*	Long-term Outcomes of Patients Receiving a Magnetic Sphincter Augmentation Device for Gastroesophageal Reflux
68	67	*Nature Reviews Gastroenterology and Hepatology*	Respiratory disease and the oesophagus: reflux, reflexes and microaspiration
69	66	*Nature Reviews Gastroenterology and Hepatology*	Mechanisms of hepatic stellate cell activation
70	66	*Nature Reviews Gastroenterology and Hepatology*	Developmental origins of NAFLD: a womb with a clue
71	65	*Clinical Gastroenterology and Hepatology*	A Diet Low in Fermentable Oligo-, Di-, and Monosaccharides and Polyols Improves Quality of Life and Reduces Activity Impairment in Patients With Irritable Bowel Syndrome and Diarrhea
72	65	*Journal of Gastroenterology and Hepatology*	History of the low FODMAP diet
73	63	*The Lancet Gastroenterology and Hepatology*	Somatic POLE proofreading domain mutation, immune response, and prognosis in colorectal cancer: a retrospective, pooled biomarker study
74	62	*Nature Reviews Gastroenterology and Hepatology*	Genetics of primary sclerosing cholangitis and pathophysiological implications
75	62	*Clinical Gastroenterology and Hepatology*	Asthma Is Associated With Subsequent Development of Inflammatory Bowel Disease: A Population-based Case-Control Study
76	61	*Nature Reviews Gastroenterology and Hepatology*	Liver transplantation for hepatocellular carcinoma: outcomes and novel surgical approaches
77	60	*Nature Reviews Gastroenterology and Hepatology*	Management of NAFLD: a stage-based approach
78	60	*Nature Reviews Gastroenterology and Hepatology*	Bile acid-microbiota crosstalk in gastrointestinal inflammation and carcinogenesis
79	60	*Nature Reviews Gastroenterology and Hepatology*	Circadian rhythms of liver physiology and disease: experimental and clinical evidence

80	59	*The Lancet Gastroenterology and Hepatology*	Evidence of reducing ethanol content in beverages to reduce harmful use of alcohol
81	59	*Clinical Gastroenterology and Hepatology*	Endoscopic Sleeve Gastroplasty Alters Gastric Physiology and Induces Loss of Body Weight in Obese Individuals
82	58	*Nature Reviews Gastroenterology and Hepatology*	Many European countries 'flying blind' in their efforts to eliminate viral hepatitis
83	57	*Nature Reviews Gastroenterology and Hepatology*	The role of the gut microbiota in NAFLD
84	56	*Nature Reviews Gastroenterology and Hepatology*	Liver — guardian, modifier and target of sepsis
85	55	*Nature Reviews Gastroenterology and Hepatology*	Direct-acting antiviral agents for hepatitis C: structural and mechanistic insights
86	55	*The Lancet Gastroenterology and Hepatology*	Prevalence of clinically significant liver disease within the general population, as defined by non-invasive markers of liver fibrosis: a systematic review
87	54	*The Lancet Gastroenterology and Hepatology*	Surgery versus conservative management for recurrent and ongoing left-sided diverticulitis (DIRECT trial): an open-label, multicentre, randomised controlled trial
88	54	*Nature Reviews Gastroenterology and Hepatology*	Bioengineering the gut: future prospects of regenerative medicine
89	52	*Nature Reviews Gastroenterology and Hepatology*	Post-infectious IBS, tropical sprue and small intestinal bacterial overgrowth: the missing link
90	51	*The Lancet Gastroenterology and Hepatology*	Neurostimulation for abdominal pain-related functional gastrointestinal disorders in adolescents: a randomised, double-blind, sham-controlled trial
91	51	*Clinical Gastroenterology and Hepatology*	Effect of Yoga in the Therapy of Irritable Bowel Syndrome: A Systematic Review
92	51	*Nature Reviews Gastroenterology and Hepatology*	Acinar cell plasticity and development of pancreatic ductal adenocarcinoma
93	51	*Clinical Gastroenterology and Hepatology*	Mood and Anxiety Disorders Precede Development of Functional Gastrointestinal Disorders in Patients but Not in the Population
94	51	*Nature Reviews Gastroenterology and Hepatology*	Contribution of gut microbiota-host cooperation to drug efficacy
95	51	*The Lancet Gastroenterology and Hepatology*	Globalisation of inflammatory bowel disease: perspectives from the evolution of inflammatory bowel disease in the UK and China
96	50	*Nature Reviews Gastroenterology and Hepatology*	Advances in the physiological assessment and diagnosis of GERD
97	50	*The Lancet Gastroenterology and Hepatology*	Symptoms and patient factors associated with diagnostic intervals for pancreatic cancer (SYMPTOM pancreatic study): a prospective cohort study
98	49	*Nature Reviews Gastroenterology and Hepatology*	Molecular subtypes in cancers of the gastrointestinal tract
99	49	*The Lancet Gastroenterology and Hepatology*	Management of the multiple symptoms of irritable bowel syndrome
100	48	*Nature Reviews Gastroenterology and Hepatology*	The potential role of optical biopsy in the study and diagnosis of environmental enteric dysfunction

Section 2: 100 most cited Gastroenterology and Hepatology articles ranked as per total citations count obtained from the Web of Sciences database.

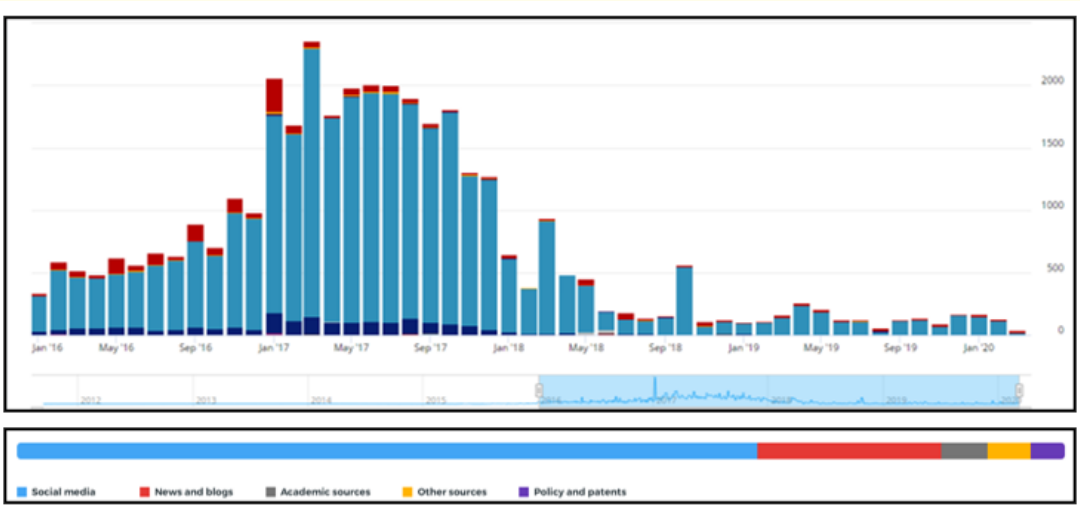
Rank	Citations count	Altmetric Attention Score	Article Title
1	1633	215	Global Epidemiology of Nonalcoholic Fatty Liver Disease-Meta-Analytic Assessment of Prevalence, Incidence, and Outcomes
2	1091	244	EASL 2017 Clinical Practice Guidelines on the management of hepatitis B virus infection
3	901	89	AASLD guidelines for treatment of chronic hepatitis B
4	788	25	EASL-EASD-EASO Clinical Practice Guidelines for the management of non-alcoholic fatty liver disease
5	705	10	Asian-Pacific clinical practice guidelines on the management of hepatitis B: a 2015 update
6	644	114	Global prevalence and genotype distribution of hepatitis C virus infection in 2015
7	597	145	Bowel Disorders
8	591	515	EASL Recommendations on Treatment of Hepatitis C 2016
9	565	26	Convolutional Neural Networks for Medical Image Analysis: Full Training or Fine Tuning
10	554	335	The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics
11	542	511	Worldwide incidence and prevalence of inflammatory bowel disease in the 21st century
12	494	97	Unexpected high rate of early tumor recurrence in patients with HCV-related HCC undergoing interferon-free therapy
13	409	2	Circular RNA circMTO1 Acts as the Sponge of MicroRNA-9 to Suppress Hepatocellular Carcinoma Progression
14	407	34	Early occurrence and recurrence of hepatocellular carcinoma in HCV-related cirrhosis treated with direct-acting antivirals
15	356	54	Functional Gastrointestinal Disorders: History, Pathophysiology, Clinical Features, and Rome IV
16	334	52	Portal Hypertensive Bleeding in Cirrhosis: Risk Stratification, Diagnosis, and Management: 2016
17	313	7	Asia-Pacific clinical practice guidelines on the management of hepatocellular carcinoma
18	312	113	Induces Resolution of Nonalcoholic Steatohepatitis Without Fibrosis Worsening
19	279	15	The Severity of Nonalcoholic Fatty Liver Disease Is Associated with Gut Dysbiosis and Shift in the Metabolic Function of the Gut Microbiota
20	276	63	Gastroduodenal Disorders
21	266	12	Daclatasvir with sofosbuvir and ribavirin for hepatitis C virus infection with advanced cirrhosis or post-liver transplantation recurrence
22	259	94	Cholangiocarcinoma: current knowledge and future perspectives consensus statement from the European Network
23	259	192	Inherited determinants of Crohn's disease and ulcerative colitis phenotypes: a genetic association study
24	257	175	The economic and clinical burden of nonalcoholic fatty liver disease in the United States and Europe

25	244	11	Non-alcoholic fatty liver disease and risk of incident cardiovascular disease: A meta-analysis
26	236	68	Toronto Consensus for the Treatment of *Helicobacter pylori* Infection in Adults
27	231	33	Impact of direct acting antiviral therapy in patients with chronic hepatitis C and decompensated cirrhosis
28	221	20	EASL Clinical Practice Guidelines: Liver transplantation
29	218	3	Liver Cancer Cell of Origin, Molecular Class, and Effects on Patient Prognosis
30	210	25	Sorafenib or placebo plus TACE with doxorubicin-eluting beads for intermediate stage HCC
31	208	24	Magnetic Resonance Imaging More Accurately Classifies Steatosis and Fibrosis in Patients with Nonalcoholic Fatty Liver
32	199	116	EASL Clinical Practice Guidelines: The diagnosis and management of patients with primary biliary cholangitis
33	198	1	Activation of the p62-Keap1-NRF2 pathway protects against ferroptosis in hepatocellular carcinoma cells
34	196	59	Childhood Functional Gastrointestinal Disorders: Child/Adolescent
35	194	17	Lack of evidence of an effect of direct-acting antivirals on the recurrence of hepatocellular carcinoma: Data from three ANRS cohorts
36	193	44	Risk of Hepatocellular Cancer in HCV Patients Treated With Direct-Acting Antiviral Agents
37	190	47	Mechanism of hard-nanomaterial clearance by the liver
38	189	2	Long Noncoding RNA DANCR Increases Stemness Features of Hepatocellular Carcinoma by Derepression of CTNNB1
39	188	31	Roles for Intestinal Bacteria, Viruses, and Fungi in Pathogenesis of Inflammatory Bowel Diseases and Therapeutic Approaches
40	188	14	Outcomes after successful direct-acting antiviral therapy for patients with chronic hepatitis C and decompensated cirrhosis
41	186	12	Chronic Infection with Camelid Hepatitis E Virus in a Liver Transplant Recipient Who Regularly Consumes Camel Meat and Milk
42	184	10	Efficacy of Direct-Acting Antiviral Combination for Patients with Hepatitis C
43	182	16	Changes in the Prevalence of Hepatitis C Virus Infection, Nonalcoholic Steatohepatitis, and Alcoholic Liver
44	180	30	Eradication of Hepatitis C Virus Infection in Patients With Cirrhosis Reduces Risk of Liver and Non-Liver Complications
45	178	19	Risk of Hepatocellular Carcinoma After Sustained Virological Response in Veterans with Hepatitis C Virus Infection
46	176	258	Obesity and Bariatric Surgery Drive Epigenetic Variation of Spermatozoa in Humans
47	175	6	Clinical Patterns of Hepatocellular Carcinoma in Nonalcoholic Fatty Liver Disease: A Multicenter Prospective Study
48	174	52	Understanding and Preventing the Global Increase of Inflammatory Bowel Disease
49	174	15	Pathobiology of Helicobacter pylori-Induced Gastric Cancer
50	173	69	Colorectal polypectomy and endoscopic mucosal resection (EMR)
51	171	9	Global trends and predictions in hepatocellular carcinoma mortality

52	168	30	Gut microbiota imbalance and colorectal cancer
53	163	220	Complementary Feeding: A Position Paper by the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition
54	163	17	Systemic Inflammation in Decompensated Cirrhosis
55	163	12	Daclatasvir, sofosbuvir, and ribavirin for hepatitis C
56	160	40	Gut Microbiota Profiling of Pediatric Nonalcoholic Fatty Liver Disease
57	160	6	Increases Risk of Nonalcoholic Fatty Liver Disease in Individuals of European Descent
58	158	22	Tremelimumab in combination with ablation in patients with advanced hepatocellular carcinoma
59	157	7	EASL Clinical Practice Guidelines on the prevention, diagnosis and treatment of gallstones
60	156	27	Individual patient data meta-analysis of controlled attenuation parameter (CAP) technology for assessing steatosis
61	156	27	Serum Levels of Infliximab and Adalimumab Are Associated With Mucosal Healing in Patients With Inflammatory Bowel Diseases
62	155	133	Efficacy of Sterile Fecal Filtrate Transfer for Treating Patients With Clostridium difficile Infection
63	153	86	Delisting of liver transplant candidates with chronic hepatitis C after viral eradication: A European study
64	149	2	Combination of Tenofovir Disoproxil Fumarate and Peginterferon
65	148	34	inflammasome blockade reduces liver inflammation and fibrosis in experimental NASH in mice
66	147	114	Gut Microbiome-Based Metagenomic Signature for Non-invasive Detection of Advanced Fibrosis in Human Nonalcoholic Fatty Liver Disease
67	147	61	Magnetic Resonance Elastography vs Transient Elastography in Detection of Fibrosis and Noninvasive Measurement of Steatosis in Patients With Biopsy-Proven Nonalcoholic Fatty Liver Disease
68	147	19	Extrahepatic Manifestations of Hepatitis C
69	146	165	Liver Stiffness in Nonalcoholic Fatty Liver Disease: A Comparison of Supersonic Shear Imaging, FibroScan, and ARFI With Liver Biopsy
70	145	69	Fibrosis stage but not NASH predicts mortality and time to development of severe liver disease in biopsy-proven NAFLD
71	144	22	Y90 Radioembolization Significantly Prolongs Time to Progression Compared With Chemoembolization in Patients With Hepatocellular Carcinoma
72	142	9	High-volume plasma exchange in patients with acute liver failure: An open randomised controlled trial
73	138	36	The Microbiome-Gut-Brain Axis in Health and Disease
74	136	3	Hepatocellular Carcinoma in the Absence of Cirrhosis in United States Veterans Is Associated With Nonalcoholic Fatty Liver Disease
75	135	469	Colorectal Cancer Screening: Recommendations for Physicians and Patients From the US Multi-Society Task Force on Colorectal Cancer
76	134	30	Incidence of Hepatocellular Carcinoma in All 50 United States
77	131	90	Oncostatin M drives intestinal inflammation and predicts response to tumor necrosis factor-neutralizing therapy in patients with inflammatory bowel disease

78	131	42	The Toronto Consensus Statements for the Management of Inflammatory Bowel Disease in Pregnancy
79	130	140	NASPGHAN Clinical Practice Guideline for the Diagnosis and Treatment of Nonalcoholic
80	130	73	p62, Upregulated during Preneoplasia, Induces Hepatocellular Carcinogenesis by Maintaining Survival of Stressed HCC-Initiating Cells
81	129	48	Glecaprevir and pibrentasvir yield high response rates in patients with HCV
82	129	14	Substitutions in HCV NS5A, NS5B, or NS3 and Outcomes of Treatment with Ledipasvir and Sofosbuvir
83	129	35	Metastatic Pancreatic Cancer: American Society
84	128	614	Probiotic *Bifidobacterium longum* NCC3001 Reduces Depression
85	128	39	Bile Acid Control of Metabolism and Inflammation in Obesity, Type 2 Diabetes, Dyslipidemia, and Nonalcoholic Fatty Liver Disease
86	128	2	Produced by T Cells Reduce the HBV Persistence Form, cccDNA, Without Cytolysis
87	127	12	Real-World Effectiveness of Ledipasvir/Sofosbuvir in 4,365 Treatment-Naive, Genotype 1 H
88	126	14	Prognostic factors and predictors of sorafenib benefit in patients with hepatocellular carcinoma: Analysis of two phase III studies
89	126	11	Effectiveness of Sofosbuvir, Ledipasvir/Sofosbuvir, or Paritaprevir/Ritonavir/Ombitasvir and Dasabuvir Regimens for Treatment of Patients With Hepatitis C in the Veterans Affairs National Health Care System
90	126	3	Neutrophils Recruit Macrophages and T-Regulatory Cells to Promote Progression of Hepatocellular Carcinoma and Resistance to Sorafenib
91	125	9	Performance measures for lower gastrointestinal endoscopy
92	125	39	Treatment of Hepatitis C Virus-Associated Mixed Cryoglobulinemia with Direct-Acting Antiviral Agents
93	124	2	Fusobacterium nucleatum Increases Proliferation of Colorectal Cancer Cells and Tumor Development in Mice by Activating
94	123	21	Eliciting the Mitochondrial Unfolded Protein Response by Nicotinamide Adenine Dinucleotide Repletion Reverses Fatty Liver Disease in Mice
95	122	162	Hydrogen and Methane-Based Breath Testing in Gastrointestinal Disorders
96	122	1	METTL14 Suppresses the Metastatic Potential of Hepatocellular Carcinoma by Modulating
97	122	18	Serum hepatitis B virus RNA is encapsidated pregenome RNA that may be associated with persistence of viral infection and rebound
98	121	44	Locally Advanced, Unresectable Pancreatic Cancer
99	120	28	Identification of an Immune-specific Class of Hepatocellular Carcinoma, Based on Molecular Features
100	120	36	Intestinal microbiota contributes to individual susceptibility to alcoholic liver disease

Section 3: Articles mentions overtime filtered by specific attention source types.



Figure

Results

The 100 most mentioned G&H articles are listed in supplementary section 1. Supplementary section 3 displays article's mentions over-time filtered by specific attention source types. Twitter remained the dominant source of attention over the years. Most twitter attention came from USA (18.5%) and UK (15.2%), and Spain (7.5%). The AAS of the 100 most mentioned articles ranged from 2123 to 48 (mean 157.7 ± 230.8; median 95.5). The citations count of these articles ranged from 601 to 1 (mean 63.68 ± 93.10; median 36). The 2018 JIF of the journals in which the top 100 articles were published ranged from 23.57 to 2.198 (mean 16.491 ± 7.282; median 12.856). The 100 most cited G&H articles are listed as per the total citations count in supplementary section 2.

The citations count of these articles ranged from 1633 to 120 (mean 248.8 ± 226; median 172). The AAS of these articles ranged from 614 to 1 (mean 73.1 ± 113.3; median 30.5). The landscape of top mentioned and top cited articles is depicted in figure 2. *'The mesentery: structure, function, and role in disease'*, published in *The Lancet Gastroenterology and Hepatology* in 2016 by Coffey., *et al*. was the most mentioned article (30). This article had an Altmetric score of 2123 (Figure 1) with 711 tweets, 307 Mendeley user bookmarks, 185 news outputs, 97 Facebook posts, 18 Google+ posts, 7 video uploads, 17 blog discussions, and 3 policy documents. The second most mentioned article was *'Disparities in Absolute Denial of Modern Hepatitis C Therapy by Type of Insurance'* by Vincent Lo Re., *et al*. published in the journal *Clinical Gastroenterology and Hepatology* in 2016 (31). The top 100 most mentioned articles were published in 7 different journals, whereas the 100 most cited were published in 20 different journals. The journals with the most mentioned and most cited articles are shown in table 1.

Journal	Top mentioned articles	Top cited articles	p-value
Nature Reviews Gastroenterology and Hepatology	48	2	0.000
The Lancet Gastroenterology and Hepatology	28	2	0.000
Clinical Gastroenterology and Hepatology	17	2	0.000
Gastroenterology	0	33	0.000
Journal of Hepatology	0	23	0.000
Hepatology	0	19	0.000

Table 1: *Journals in which the most mentioned and most cited G&H articles were published.*

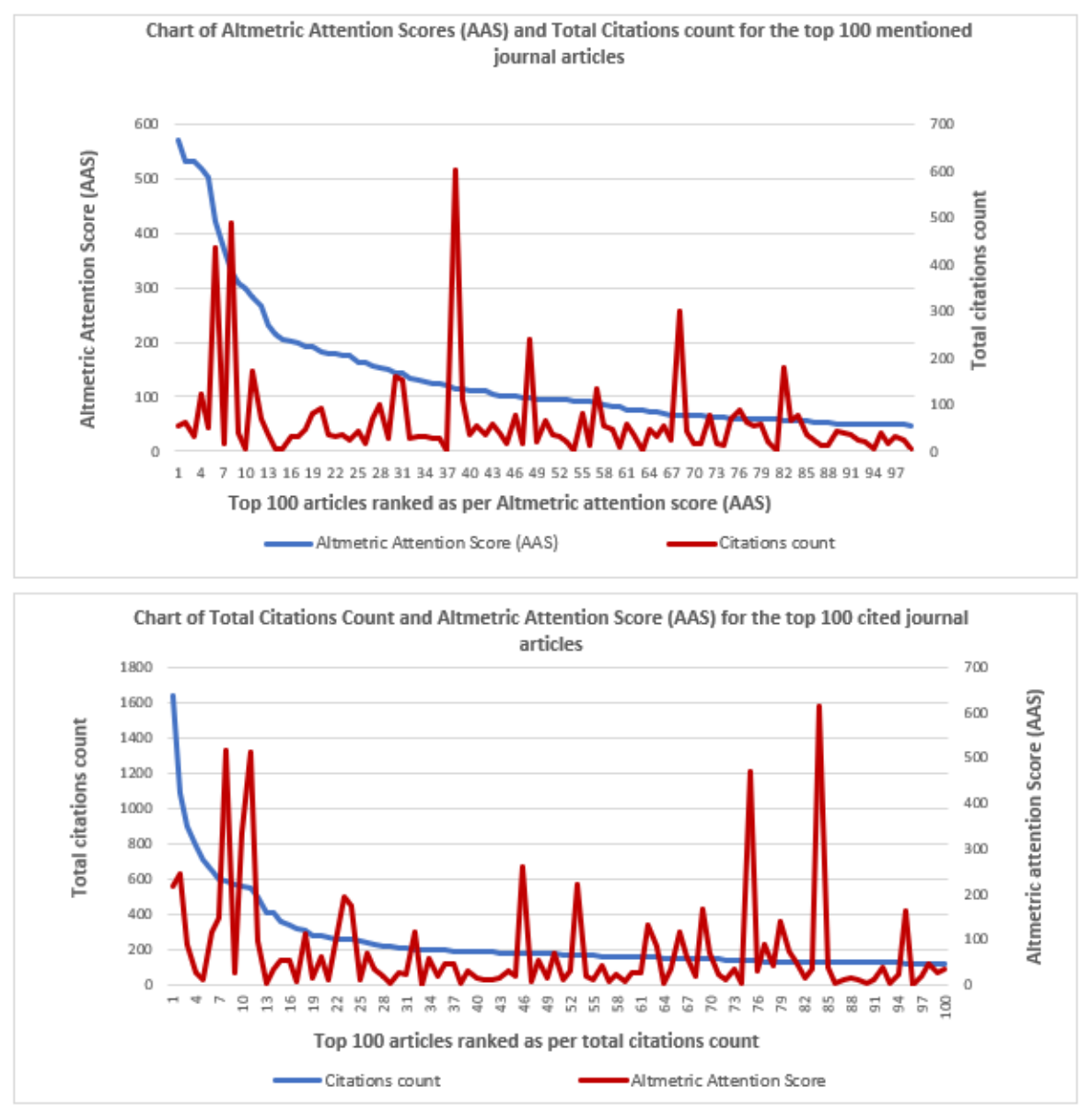
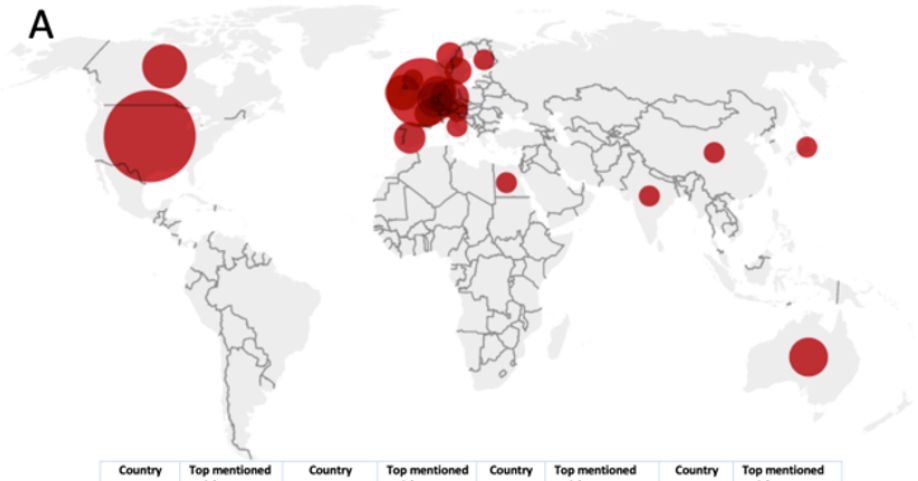


Figure 2: *Landscape of most mentioned and most cited G&H journal articles. The top chart shows that no correlation exists between the Altmetric Attention Score (AAS) and the total citations count for the 100 most mentioned journal articles. The same relationship is observed for the 100 most cited journal articles in the bottom chart.*

The top 100 mentioned articles originated from 20 different countries with majority originating from USA (35) and England (19). USA (37) was also the leading country from which most cited G&H articles originated; with 21 others contributing to the top 100 most cited articles list (Figure 3). The type of research for the most mentioned and most cited articles are listed in table 2.

A



Country	Top mentioned articles	Country	Top mentioned articles	Country	Top mentioned articles	Country	Top mentioned articles
USA	35	BELGIUM	4	SWEDEN	2	FINLAND	1
ENGLAND	19	IRELAND	4	FRANCE	2	INDIA	1
CANADA	7	NETHERLANDS	4	AUSTRIA	1	ITALY	1
AUSTRALIA	5	SPAIN	3	CHINA	1	JAPAN	1
GERMANY	5	NORWAY	2	EGYPT	1	SCOTLAND	1

B

Country	Top cited articles	Country	Top cited articles	Country	Top cited articles	Country	Top cited articles
USA	37	SWITZERLAND	5	AUSTRIA	1	POLAND	1
CHINA	9	GERMANY	3	INDIA	1	SCOTLAND	1
FRANCE	8	SPAIN	3	IRELAND	1	SINGAPORE	1
ITALY	8	AUSTRALIA	2	ISRAEL	1	SWEDEN	1
ENGLAND	6	DENMARK	2	NETHERLANDS	1	TAIWAN	1
CANADA	5	JAPAN	2				

Figure 3: *Countries from where the 100 most mentioned (A) and most cited (B) G&H articles originated. (www.datawrapper.de). Both maps show that the majority of most mentioned and most cited journal articles originated from North America and Europe.*

Research type	Top mentioned articles	Top cited articles	p-value
Review Articles	54	11	0.000
Original Research	33	49	0.031
Systematic Reviews/ Meta- Analysis	7	6	1.000
Other (Editorial article/ Letter)	4	0	0.121
Clinical Guidelines/ Consensus Statement	2	19	0.000
Basic Research	0	15	0.000

Table 2: *Type of research articles.*

Of the most mentioned original articles, 14 were randomized control trials (RCT), 10 were cohort studies and 4 each were case controlled and cross-sectional studies. There was no statistical difference between the AAS and citations count for the type of most mentioned research articles using Mood Median statistical test (p: 0.329, p: 0.103). The mean AAS for the most mentioned articles published in the years 2016 and 2017 were 191 and 137 respectively (p: 0.342, two sample t-test). The mean citations count for these articles were 61.7 and 65 respectively (p: 0.851, two-sample T-test). The most common topics for the most mentioned and most cited articles are shown in table 3.

Topics	Top mentioned articles	Top cited articles	p-value
Inflammatory bowel disease	15	7	0.112
Gut Microbiota	15	3	0.005
Functional GI disorders	10	5	0.283
Hepatitis C	8	20	0.024
Colon cancer	6	3	0.498
Non-Alcoholic fatty liver disease	6	22	0.002
Coeliac disease	5	0	0.059
Alcohol liver disease	3	1	0.621
Gastro-esophageal reflux disease	3	0	0.246
Pancreatic cancer	2	1	1.000
Hepatocellular carcinoma	1	23	0.000
Hepatitis B	0	6	0.029
Endoscopy	0	2	0.497
Liver Transplant	0	3	0.246

Table 3: *Topics with most research articles.*

The top 100 mentioned articles were analyzed for correlation between the AAS and different online media outputs i.e. twitter mentions, news mentions, Facebook mentions, and number of Mendeley readers. There was a positive correlation between AAS and each of (i) number of Mendeley readers (5.8%), (ii) twitter mentions (35.9%), (iii) Facebook mentions (57.3%) and (iv) news mentions (84.4%). There was also a positive correlation between the citations count and each of twitter mentions (15.0%) and the number of Mendeley readers (69.2%) (Figure 4). There was no statistically significant correlation between AAS and each of citations count and JIF (r^2: 1.2%, r^2: 0.7% respectively) for the most mentioned articles. Also, there was no correlation between JIF and AAS (r^2: 5.9%) for these articles.

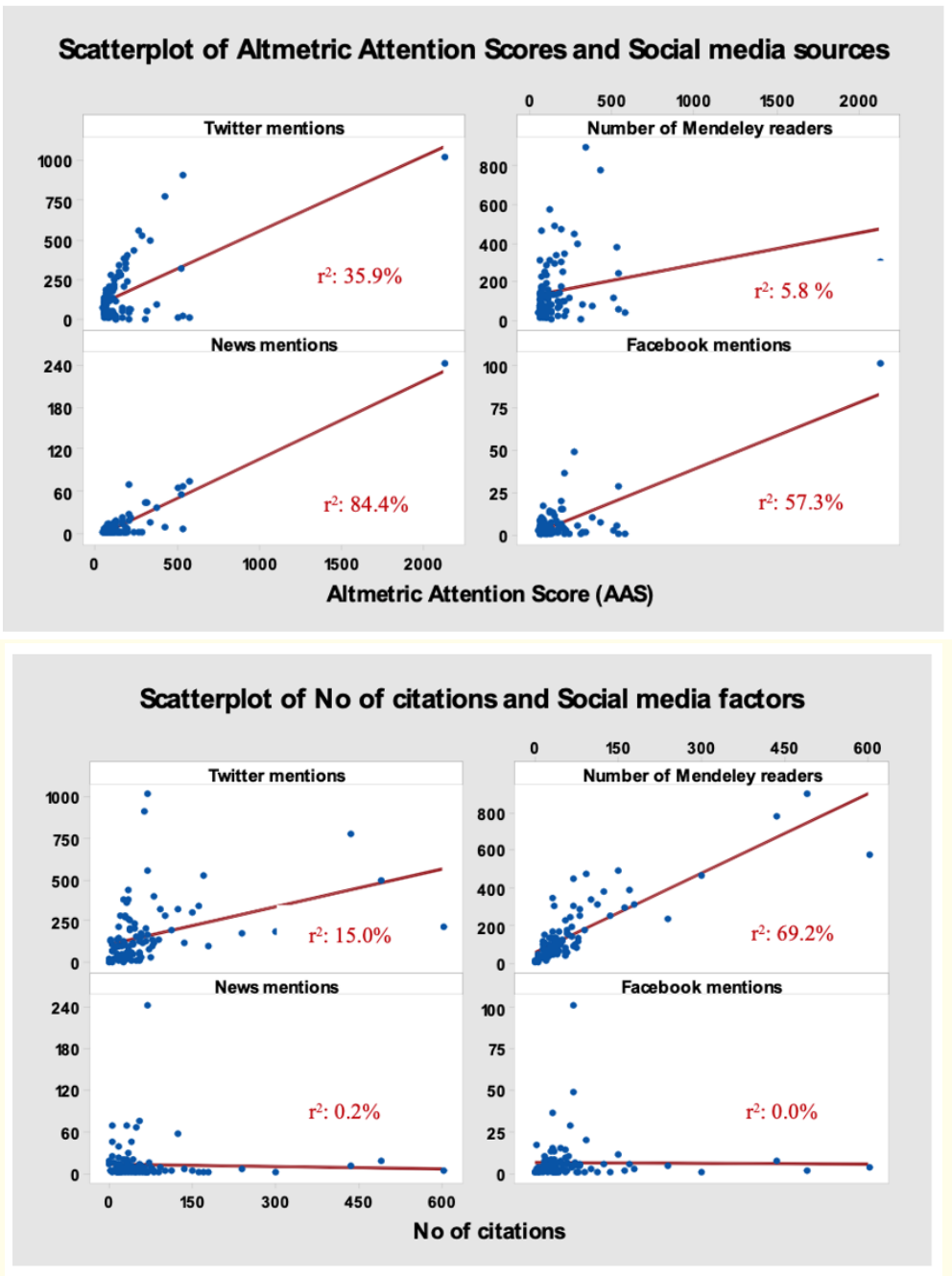


Figure 4: *Regression analysis of social media factors against Altmetric score and citations count for most mentioned research articles. For the most mentioned journal articles regression analysis shows a positive correlation between Altmetric Attention Score (AAS) and different online media source outputs (i.e. number of Mendeley readers, twitter mentions, Facebook mentions and news mentions). A positive correlation only seen between the total citations count and each of twitter mentions and the number of Mendeley readers.*

Discussion and Conclusion

To the best of our understanding, this is the first research to measure the dissemination of Gastroenterology and Hepatology research using both alternative metrics and bibliometrics. Traditionally, JIF and citation analysis have been utilized as the fundamental pointers for estimating research impact [2,4,32]. But these have been criticised for failing to reflect wider research impact such as educational and social impact on non- scientific population [2,5-8]. With the changing behaviour within scientific community regarding creating and sharing of knowledge since the evolution of internet, alternative metrics based on online attention of the research articles have gained traction. These have been advantageous in measuring the impact of scientific research more rapidly and widely as compared to citations metrics [5,6,8,13]. The idea of utilizing alternate metrics to evaluate social impact was presented around 10 years ago as "article-level measurements" [33] and "Scientometrics 2.0" [34]. This further evolved into "Altmetrics: A Manifesto" [35]. This was subsequently named "altmetrics", shorthand for alternative metrics. Altmetrics calculate the impact of scientific research based on online research outputs, such as social media, online news media and online reference managers [36,37]. It exhibits both the effect and the point by point synthesis of the impact. Altmetrics depend principally on web-based networking media yields like ResearchGate, Mendeley, Twitter, news media, Facebook, Google+. Altmetrics are fast relative to citations and provide almost real-time impact of scientific research. Altmetrics cover not only journal publications, but also datasets, experimental designs, nanopublications, blog posts, comments and tweets [38].

The AAS of the 100 most mentioned articles ranged from 2123 to 48 (mean 157.7 ± 230.8; median 95.5). The most mentions that contributed to the AAS came from USA and UK. As our inclusion criteria for publications was from 1st January 2016 to 31st December 2017, we noted that the highest numbers of mentions for these publications were from Jan 2016 to May 2018, which shows that the dissemination of research online is rapid. An observation previously reported in a study examining the web usage statistics as predictors of later citations [5]. We noted that the most mentioned articles were mostly published in review journals, i.e. *Nature Reviews Gastroenterology and Hepatology* [48] and *The Lancet Gastroenterology and Hepatology* [28], whereas the most cited articles were mostly published in journals mainly publishing original research, i.e. *Gastroenterology* [33], *Journal of Hepatology* [23], *Hepatology* [19]. The top most-mentioned and most cited articles originated from 26 different countries, demonstrating a good distribution of G&H research. The majority of the most mentioned and most cited articles originated from Europe and North America with USA having the highest number of top mentioned [35] and top cited (57) articles.

Again, as with the publishing journals described earlier, the most mentioned articles were review articles (54%), whereas the most cited articles were original research articles (49%). Also, interesting to note is that although basic research articles make up 15% of top cited articles, they do very little in generating online media attention with no basic research articles making it in the top 100 most mentioned articles. As expected, clinical guidelines and consensus statement are highly citable with making 19% of the top cited articles, surprisingly only 2 of these made it to top 100 most mentioned articles.

There was also variation between the research topics for the most mentioned and most cited articles. Inflammatory bowel disease [15], gut microbiota [15] and functional GI disorders [10] made nearly half of most mentioned articles. Whereas hepatocellular carcinoma [23], hepatitis C [20] and non-alcoholic fatty liver disease [22] made more than half of the most cited articles. Of the top 100 most mentioned articles, randomized controlled trials (RCT) made 43.75% of the original articles. For different article types (reviews, original articles, systematic reviews/ meta-analysis, consensus statements, editorial material, letters) we found no statistical difference between the AAS and the total number of citations. This is in contrast to previous studies that have shown that review articles generally gather more citations [39,40]. However, given the small sample size and unequal distribution of data, our study was not specifically designed to study this hypothesis and therefore no conclusions can be drawn.

Regression analysis revealed a positive relationship between AAS and online media output sources such as Facebook, Twitter, Mendeley and news mentions; thereby demonstrating that these online resources can be used for rapid dissemination of research. This is com-

parable to previous study demonstrating positive correlation between twitter mentions and AAS [14]. No correlation was found between the citations count and online media sources such as news mentions and Facebook, an effect that has previously been demonstrated in literature [41-43]. There was however, positive correlation of citations count with number of Mendeley users and Twitter mentions, which is similar to what has previously been demonstrated in publications characterizing social media metrics of scholarly papers [14,26,44]. No conclusions can be drawn between the correlation of AAS with JIF and the citations count due to small number of journals and unequal distribution of articles in our study. However previous studies have shown that JIF is an important determinant of future citations, as it is considered that top journals contain higher quality content and thus are cited more [44].

High impact articles are also read more on Mendeley, tweeted more frequently, have more Facebook posts and more blog posts in news reports [45]. There was no significant association between AAS and the citations count (r^2: 1.2%) for the most mentioned articles. Several other studies have found weak associations [46-48]. Others concluded that the factors that drive citations and altmetrics measure different type of impacts of the scientific research [49,50]. While citation analysis determine the 'academic value' of the scholarly articles, altmetrics reflect the 'disseminative impact' based on public interest [50].

By using almetrics, this study provides a detailed list of 100 most mentioned publications in Gastroenterology and Hepatology in online media. Our findings provide useful information on the dissemination of Gastroenterology and Hepatology research within the public domain. Our study highlights that both bibliometric and altmetrics measure different impacts of scientific research and altmetrics act as a useful complementary tool to traditional metrics to rapidly measure the dissemination of scientific research in the wider population. We propose the use of social media sources such as Facebook, Twitter, Mendeley and news outlets by researchers, institutions and journals to rapidly disseminate their research to a wider population.

Limitations of the Study

Our study had some inherent limitations. The retrospective and cross-sectional nature of the study brings with itself the limitations of the study design. We only used Altmetric.com for evaluation of alternative metrics. However, there are other online sources that can be used for similar purposes (example but not limited to *Plum Analytics, ImpactStory, and ALM-PLoS*) and these may very well reveal different results.

As the aim of our study was to evaluate the most influential topics and not necessarily differentiate between different study types, we therefore included all types of publications. However, future studies only incorporating original research articles will be interesting to look at and may reveal different results.

Then there are limitations with the altmetrics score itself: (i) Social media presence obviously is the key predictor of altmetric score and the journals, authors and publishers with strong online presence will likely have higher altmetric score as compared to those with limited online presence; (ii) The newer research articles have an inherent advantage over the older ones, as the ever-increasing number of online users will drive the altmetric score for the newer articles higher; (iii) In countries with limited access to social media and scarce internet sources, the utility and reach of altmetrics may be limited; and finally (iv) altmetrics measure attention and not the quality of scientific research.

Disclosure Statement

I confirm that all authors have contributed to and agreed on the content of the manuscript. The manuscript has not been published previously, in any language, in whole or in part, and is not currently under consideration elsewhere. This study did not involve human subjects and thus did not require ethical approval from an institutional review board. The authors have no conflicts of interest to declare in the outcome of this research.

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