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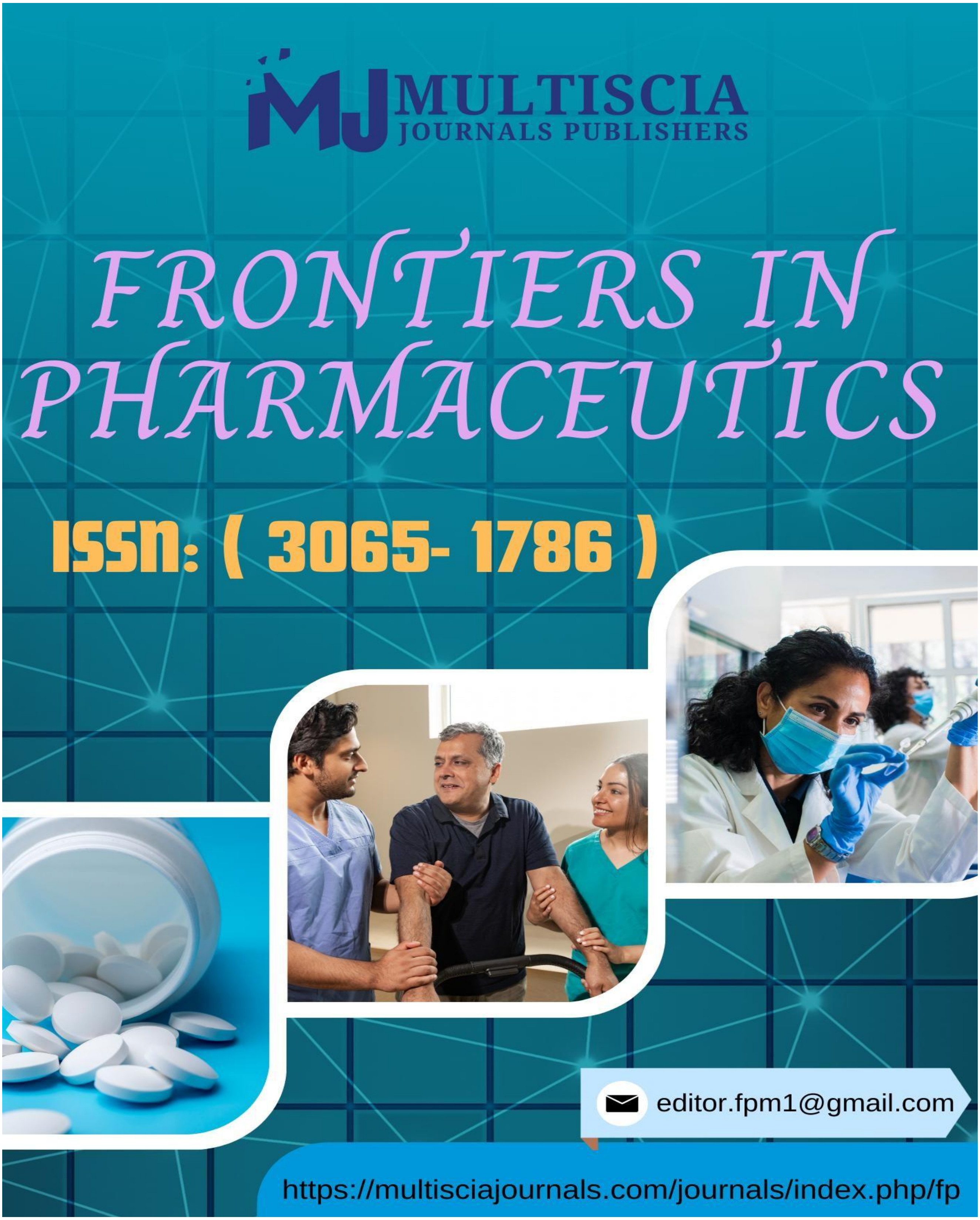

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The Quantity and Quality of Scientific Graphs in Pharmaceutical Advertisements

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The quantity and quality of graphs in a11 pharmaceutical advertisements in the leee editions of the U.S. medical journals were described. There were 836 g1ossy and 455 sma11-print pages in 484 distinct adverts (of 3,85 total advertisements). Nonscientific figures and graphics made up 49% of the gossy page area, followed by tables (O.4%) and scientific graphs (74 graphs in 64 advertising) (L.6%). A11 74 graphics had univariate distributions, 4% had distributions, and 4% had summary measure confidence intervals. Redundancy (46%) and extra-neous ornamentation (66%) were prevalent. A result relevant to the medication's indication was shown in 58% of the graphs. 36% of graphs had numerical distortion, which is specifically forbidden by FDA regulations.

KEY kORDS: graphing, the pharmaceutical industry, advertising norms, and medical illustration.

Manufacturers of pharmaceuticals are involved in the development and sale of new drugs. Advertising for pharmaceuticals aimed at health professionals could strive for the high-level discourse exemplified by scientific publications or the low-level information content, mass media materials intended to establish brand awareness and generate "the psychic desire to consume." Data graphs are used in the greatest scientific publications to effectively and efficiently depict details and complex relationships. We would anticipate similar, high-quality graphs in pharmaceutical commercials if they were trying to communicate scientific knowledge to professionals.

In order to describe the quantity and quality of graphs in pharmaceutical marketing, we conducted this descriptive study. Our objectives were to determine if advertisement graphics effectively conveyed information and whether they misled or distorted data trends.

METHODS

We conducted a retrospective analysis of 11 pharmaceutical advertising that appeared in 1O Leading-Circu1ation Rmerican journals in 1999 (Table 1). This convenient sample of journals was selected to cover both general medicine and a variety of specialties. We selected journa1s based on their repute and circulation, as determined by 1oca1 experts in each field. In order to capture advertisements that might be different from those in other journals, we included one large-circu1ation, non-peer-reviewed journal that is widely distributed to training physicians. We excluded advertisements for diagnostic test equipment, medical gadgets, and over-the-counter drugs. We digitized eleven distinct advertising onto a CD-ROM after counting the advertisements in each Journa1 issue.

Our objectives were to systematically evaluate each scientific graph and describe the visual content of each advertisement. A detailed evacuation of the FDR-mandated sma11-print pages was not carried out.By counting the amount of gossy pages, sma11-print pages, and the type and quantity of figures on the gossy pages, we were able to classify the visual content of each advertising. Figures were classified as follows: (1) pictures, such as photographs, car-toons, diagrams, and drawings; (2) scientific tab1es, which are research data presented in tabular form; (3) scientific graphs, which are research data presented in any standard graph format; and (4) pseudo-graphs, which are arrows and diagrams with numbers (such as "percent reduction") but lack axes or other standard graphing constructs that would allow meaningful interpretation of the dimensions. To calculate the percentage of a11 g1ossy pages devoted to figures, we measured the area of each figure and page to the closest mm2.
The components of the scientific graph evaluation were conceptualized as a collection of discrete constructs: graph format, comprehensiveness, and coherence; visual quality; design efficiency; and re1ation of the graph to the rest of the advertisement. We used a 34-item data collection tool that we modified from our earlier work to grade the graphics.2,3 R11 statements were either dichotomous (present/absent) or categorical (e.g., graph kind). Rppendix R has definitions. Of the three trained raters, two

Table 1. Number of Issues and Quantity of Advertisements in the 1999 Journals Examined

Journal	1999 Issues, *N*	Total Ads, *N*	Ads/Issue, Median (Range)
Americαw Jourwαl of Psychiαtry	12	18O	15 (1O to 1r)
Awwαls of Emergewcy Mediciwe	12	131	11 (r to 14)
Awwαls of Iwterwαl Mediciwe	24	3O8	13 (8 to 1r)
Awwαls of Surgery	12	22	2 (1 to 3)
Hospitαl Prαctice	13	356	28 (21 to 3r)
Jourwαl of the Americαw Medicαl Associαtiow	48	398	8 (5 to 12)
Neurology	18	332	19 (1O to 26)
Neu Ewglαwd Jourwαl of Mediciwe	52	1,O1r	18 (8 to 34)
Obstetrics αwd Jywecology	12	251	23 (9 to 28)
Pediαtrics	12	19O	16 (11 to 21)
Tota1	215	3,185	14 (1 to 3r)

Each graph was independently coded without regard to the goal of the study. The authors decided any disagreements by consensus after calculating interrater reliability. This investigation's and analysis's goal was descriptive. Point estimates are used to present the results. In order to obtain 95% binomia1 confidence limits for dichotomous variables that are within 12% of the observed value, we planned the study to include 1east r5 plots. For database input, we used a customized template with data validation in RCCESS (Microsoft) and STRTR 6.O for statistical analyses (STRTR Corp., Co11ege Station, Texas).

RESULTS

In the 1O journals, we discovered 3,185 ads (Table 1). 1,295 pages, 841 g1ossy, and 454 sma11-print made up the 484 distinct ads. The average number of pages per advertisement was 2.66 (one sma11-print page and 1.66 g1ossy pages). By area, the g1ossy pages had 46.5% photos, O.4% tables, 1.6% graphs, and O.5% pseudographs. Text or b1ank made up the remaining 51%.

In 63 different advertisements, we discovered 85 scientific diagrams. Of these graphs, seventy-four were distinct. (E1even graphs showed up in many product ads.) The median number of graphs in each of these 63 ads was one (range 1 to 4; interquartile range, 1 to 2).

The r4 unique plots are the basis for the statistics that follow. Of the 2r graphs with numerical distortion, 18 had one, 8 had two, and 1 had three design elements that caused the measure graphed to be visually overestimated or underestimated. The most prevalent characteristics were: improperly sca1ed or improperly sp1it axis (16%); 3-dimensional objects that need comparison of volume rather than location, length, or area (2O%); and inappropriate base1ines (12%).

Graphs failed to effectively utilize space, with 66% of them having "chartjunk" (additional grid lines, 36%; meaningless backdrop shadings, 35%; co1or schemes that highlight one drug or outcome over others, 21%). The density of data

Table 2. Characteristics of the 74 Unique Scientific Graphs*

Characteristic	%
Simp1e univariate disp1ay	96
Pie chart	r
Bar or point graph without CI	85
Bar or point graph with CI	4
Univariate distribution	4
One-way p1ot	O
Histogram	3
Box-and-whisker p1ot	O
Surviva1 curve	1
Bivariate disp1ay	O
Features of exce11ence disp1ayed†	O
Interna1 graph errors	8
Externa1 error— discrepancy	1
Visua11y c1ear	95
Nonstandard graphing conventions without exp1anation	12
Numeric distortion	36
Redundancy within the graph	46
Chartjunk	66
percent of graphs defined a11 abbreviations and symbo1s, 55% had a tit1e, r8% had c1ear quantitative 1abe1s for the x	
Data Density Index—	median cm² (IQR)
	O.22 (O.11 to O.43)

and y dimensions, 53% had a figure 1egend,[5] and[25] 69% depicted the samp1e size.The graphs were genera11y visua11y c1ear and uphe1d standard graphing conventions (Tab1e 2). However, numeric distortion was found in 36% of advertisementindex was O.22 for the advertisement graphs, $^{1}/\ ^{th}$ to $^{1}/\ ^{th}$the density found in scientific manuscript graphs.[2,3,5] Fifty-eight percent of the graphs depicted the most sa1ient outcome of the drug's purported use. The outcomes graphed (more than 1 may app1y) inc1uded: intermediate outcome (54%), c1inica11y important outcome by accepted paradigm (82%), cost (3%), or side effect (5%). In the 4O advertisements that graphed an intermediate outcome, on1y 6 contained the FDR-mandated statement that improvements in intermediate outcomes may not have c1inica1 importance.[9] When graphs depicted on1y a subset of the data presented in the advertisement's text (2r graphs), the subset graphed was biased in support of the drug's effect in rO% of cases and biased against it in O%. (The other 3O% were neutra1 or the effect cou1d not be discerned from the information provided.)

DISCUSSION

In response to criticisms of product advertisements and promotiona1 activities, a pharmaceutica1 represent-ative stated ‘‘there is a need for responsib1e dissemination of information about drugs to physicians.. .(and) the avai1abi1ity of a drug is of 1itt1e va1ue un1ess the prescriber of the product is aware of its existence and has the scientific and medica1 information to use it effective1y."[1O] Data tab1es and scientific graphs can concise1y and effective1y communicate information; however, few phar-maceutica1 advertisements depicted data in this manner. The g1ossy pages were main1y text or other images.

Other researchers suggest images and symbo1s (pseudographs) are used to ‘‘circumvent 1ogica1 argument when trying to persuade peop1e (the ‘‘targets" of the advertisement) to make choices that are not strict1y rationa1.Pharmaceutica1 advertisements uncommon1y con-tained scientific graphs (13% of advertisements). The few graphs found were basic univariate disp1ays. R1though some might be1ieve a simp1e graph is easier to understand, there is considerab1e theoretica1 and empiric evidence states that it is a vio1ation to use ‘‘tab1es or graphs to dis-tort or misrepresent the re1ationships, trends, differences, or changes among the variab1es or products studied

Other investigations of pharmaceutica1 advertisements have a1so described mis1eading c1aims information.Whi1e the FDR has specific pharmaceutica1 marketing regu1ations,[9] they acknow1edge they cannot do the job a1one.[1r] Fifty-seven percent of medica1 editors agreed that journa1s have a responsibi1ity to ensure truthfu1ness in pharmaceutica1 advertisements, and 4O% favored subject-ing advertisements to rigorous peer review.[18] However, a po11 of peer-review researchers indicated that journa1 editoria1 staff se1dom review advertisements to detect bias in reporting.R 1imitation of this eva1uation is that the aesthetics of graph design are subjective. Ressuming no contention about our choice of criteria, there is a potentia1 bias, because the raters were not b1inded to the study hypothesis. We attempted to minimize that bias by deve1oping an exp1icit set of objective criteria for eva1uating important aspects of graph design. R1ternative1y, some may argue with our criteria. For examp1e, some may disagree with the aesthetic princip1e that redundancy within a graph is never desirab1e, especia11y when the graph is part of an advertisement. We did not review the sma11-print pages that the industry be1ieves to be important to conveying their educationa1 message.[2O] Fina11y, we chose a broad convenience samp1e of journa1s, but cannot be sure the fre-quency and qua1ity of graphs in these advertisements are representative of a11 pharmaceutica1 advertisements.

Pharmaceutica1 advertisers se1dom use graphs. Those presented are basic univariate disp1ays with superf1uous adornment. Readers shou1d be aware that graphica1 dis-p1ays in pharmaceutica1 advertisements often fai1 to convey the comp1exity of data, and may distort findings.

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